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FREEDOM OF THE UNIVERSITIES OF GREAT BRITAIN

THE report of the University Grants Committee on "University Development 1947 to 1952", which is summarized elsewhere in this issue (p. 180), covers a period of great expansion, both in the size and in the cost of the universities of Great Britain, and while reasons are given for believing that no further increase in the number of students is probable or advisable during the coming quinquennium, the report is equally clear in its evidence that the rise in costs is likely to continue. On the financial side, the outstanding feature of the review is the picture it gives of the increasing dependence of the universities on government support and of the extent to which the rising expenditure of the universities is determined by factors, such as increased prices and wages and salaries, which are largely outside their control. Any attempt to hold university expenditure at its present level must force the universities to curtail their existing activities, either by interrupting developments or by reducing admissions, or both.

The dependence of the universities upon State aid is, in fact, likely to grow rather than to diminish, and in discussing this dependence and its reconciliation with the maintenance of academic autonomy, the University Grants Committee points out that there are other factors making for the continued increase in expenditure. The relatively low average age of academic staffs, for example, after a period of intensive recruitment, which brought the total up to nearly 9,000 (as compared with the 10,000 which it was estimated would be necessary) in place of the pre-war 4,000, and a staff/student radio of 1 : 8 instead of the pre-war 1 : 10, means that it will be some time before the full financial effects are felt of such increases in staff. Moreover, the growth of scientific knowledge, depending in turn on greater specialization, increasing numbers of workers, and increasingly costly apparatus and equipment, is likely to be a continuing cause of increased expense which, from the national point of view, cannot be regarded as optimal. The period of consolidation, which the Committee regards as likely to characterize the present quinquennium, holds no hope of a decrease in university expenditure. On the contrary, a continued increase is likely to be demanded in the national interest, and for this the University Grants Committee can see no alternative to an increasing Treasury recurrent grant.

This position is regarded with some anxiety. There is no suggestion in this report that any pressure has ever been put upon the universities in Great Britain by the Government. Successive Governments have repeatedly expressed their recognition of the desirability of preserving the autonomy of the universities; nor did the Select Committee on Estimates, in its examination of the work of the University Grants Committee during the 1951–52 Session, find any evidence that this autonomy was endangered, though it did point to the desirability of some closer control over the spending of the non-recurrent grant

and of somewhat fuller information being supplied regarding its expenditure. For the rest, the Select Committee was content to remark that the increasing dependence of the universities upon public money and the absence of direct Parliamentary control over the way the grant is spent involve a correspondingly increased responsibility on the part of each university to ensure that its affairs are managed with due economy and in the best interests of the nation.

That much is fully recognized by the University Grants Committee, which, however, points out that its financial responsibility to the Government contains a latent contradiction to its trusteeship to the universities as guardian of academic liberty; and this success in the discharge of both functions is a tribute to the forbearance of both parties. The universities have recognized that the Committee's responsibilities to the tax-payer prevent it from supporting all the developments that may be academically desirable, while the Government has recognized that the importance of academic independence justifies a freedom from control that would not ordinarily be allowed to bodies so largely financed from public funds.

The University Grants Committee professes to be confident that the partnership and forbearance already developed will continue. The universities, it thinks, fully recognize they have a special obligation to observe strict economy in the expenditure of such public monies, and that the continuance of their present financial privileges is dependent on the continued exercise on their part of a strong and evident sense of financial responsibility, which the quinquennial system itself fosters. Moreover, while without the State the universities cannot obtain sufficient funds to enable them to do their work, without the universities there would be no way of meeting the need for men and women adequately trained to advance knowledge and to hold positions of responsibility in government, industry and the professions.

That this mutual dependence is fully realized on both sides is the chief reason for the confidence of the University Grants Committee for the future, and the direct danger to university autonomy is probably slight. The danger of indirect government guidance of academic policy is, however, much more serious. The interdependence of government and universities is now so firm that no purely administrative device, such as the University Grants Committee or the quinquennial grant, can by itself secure the independence of the universities. The continuance of academic autonomy depends not simply on the degree of good sense and moderation displayed by the universities: it depends above all on the extent to which public opinion understands the reasons why academic autonomy is important and is willing that such autonomy should continue.

The University Grants Committee itself is clear enough that the universities may be called upon to resist sectional clamour. A situation could easily arise, it points out, in which the universities could only meet the demands made upon them by distorting the balance of their work and neglecting studies or teaching which may really be of greater importance, though lacking at that time the advocacy of those with particular interests. The balance of university activity which is desirable in the long-term interests of the community as a whole will not necessarily, or even probably, be the same as that which would result from an uncritical acceptance of all such demands.

There is a special reason for welcoming, at this particular juncture, the unequivocal declaration in this report that, in deciding whether a particular activity should be undertaken by a university, and if so on what scale, the last word should continue to be that of the university itself. Within the past few weeks, a document has been issued by a major political party setting out a programme which includes a proposal on which it is difficult to place any other interpretation than that universities are to be told by the Government of the day what they are to teach. There may be occasions, as the Select Committee on Estimates observed, when the universities themselves may not be in a position to be the best judges of what studies most need to be developed in the national interest. Such occasions can at least be met through the University Grants Committee, even though the device of the ear-marked grant has been explicitly discontinued. To determine the content of academic studies at the behest of a political party or any other external body is another matter, and in resisting such pretensions the universities and the University Grants Committee should have the support of all who are concerned to uphold the high standards and ideals which have won for the universities of Great Britain and the University Grants Committee the respect of the free world.

It is clear from this report that the University Grants Committee itself is not satisfied that the curricula of the universities or the organization of teaching take full account of the changes in the economic and social background of the student of to-day. It is also clear that the universities themselves are already examining the situation, and that the University Grants Committee is fully alive to the implications of the situation. To suggest, however, that the teaching at the universities should take account of changes in our way of life and the community's needs and in that context to advocate appointment of a Royal Commission can only mean that politicians are to be invited to teach the universities their business. The consequences to education and to science of such procedure are writ large in the history of universities in Germany and elsewhere during the inter-war years.

That, however, is not the sole reason for concern at the possibility of indirect influence upon university policy or for welcoming a much more vigorous campaign to secure public understanding of the work and function of the universities in Britain to-day. "University Development 1947–1952" was in the press when the political manifesto already mentioned was issued; but it supplies a complete and dignified answer to the suggestion that the universities are stagnant and out of touch with the needs of to-day. The consolidation of the advances of the past five

years, which the universities have recognized as the main task of the present quinquennium, is over much of the field not stagnation. Within the existing general pattern, there is much scope for development and experimentation, and the University Grants Committee notes the persistence within the universities of the mood of criticism and self-examination on which it commented in its last report. Universities, it adds, cannot remain static if they are not to lose their vitality; and while the attitude of the universities to new demands will be determined by their view of their functions, this concept must itself be kept flexible and responsive to the needs of a new age.

Even in Great Britain, the functions of all university institutions are not the same. The universities and university colleges of Great Britain include institutions of a wide variety of types, ranging from the old universities to the smaller foundations which came into being within the past generation. Some of them are consciously experimenting in order better to fulfil what they regard as their proper functions. The report mentions specifically the declared aim of the new University College of North Staffordshire to offer a new type of curriculum, in which the first year of the degree course is "designed as a whole to give an understanding of the heritage of Western civilization, of modern society, and of the nature, methods and influence of the experimental sciences". The University Grants Committee regards a readiness to experiment as important for the development of university policy; and, at a time when there is a pronounced disposition in some quarters to stamp uniformity on the field of education, it has done well to direct attention to the importance of such diversity.

Except perhaps in relation to its bearing on academic staff, the University Grants Committee does not discuss either the teaching or the research function of the university at such length as in earlier reports. Yet the broader purposes of a university education, it points out, were never more important than they are to-day. "Society requires of the university graduate much more than his degree or his expert knowledge of a particular field. It also requires the breadth of outlook necessary for those who are to fill positions of responsibility, and a university cannot be said to have risen to the height of its obligations until it has so designed its teaching as to ensure for all its students who use their opportunities the chance to become, in words spoken by J. S. Mill more than eighty years ago, 'capable and cultivated human beings'."

Both research and teaching incur some dangers through specialization and departmentalism, and it is clear that the University Grants Committee is fully alive to the dangers of fragmentation. While it thinks there is little danger of sponsored research distorting the balance of work in British universities, it deprecates the multiplication of fields of study in the universities without prior consideration of the alternative of development in a specialized research institute. Moreover, the increase in the number of university professors since the Second World War has been due less to the increase in student numbers than to the growth in the volume of new knowledge; and because pursuit of new knowledge becomes increasingly more costly—not only on account of the larger academic staff required, but also because apparatus becomes more elaborate and the size and cost of libraries continually rise—the universities can only maintain their part in the pursuit of new knowledge by increasing dependence on the State.

This latter note is struck more insistently and repeatedly in relation to the distribution of students and the demands of particular fields of study. While the University Grants Committee takes a reasoned view that the total number of university students in Britain is likely to remain relatively stable for some years to come, and even that no increase is likely to be possible without some fall in quality—at least until the increased birth-rate of the latter part of the War begins to take effect—it does not exclude the desirability of changes in distribution between the faculties. Indeed, it suggests that there will be a tendency for the proportion of students of science and technology to grow at the expense of the proportion of arts students, and that such a tendency is desirable in the national interest and should be encouraged.

More, however, is involved than a mere transfer of numbers, and it is here that the University Grants Committee gives repeated warning and that the danger of indirect political pressure recurs. A student in science and technology requires more costly and elaborate accommodation and equipment; and even if the number of arts students falls considerably, an increase in the number of students of science and technology would require capital expenditure on buildings and equipment. The University Grants Committee is firmly opposed to the continuance of the over-crowded and makeshift conditions which characterized the immediate post-war expansion, and quite rightly it postulates as an essential condition of any such expansion on the science and technology side that the necessary additions to accommodation and equipment shall be forthcoming. It emphasizes repeatedly that the position here is unsatisfactory and uncertain. Not only has the Government been unable or unwilling to undertake long-term commitments, but also the doubling in five years, instead of the ten years proposed by the Barlow Committee on Scientific Man-power, of the number of science students, as well as rising prices, have falsified completely the Committee's estimate in 1947 of the capital expenditure required for that purpose.

At this point the report of the University Grants Committee leaves the same outstanding impression as the Eighth Report of the Select Committee on Estimates, dealing with the schools, published a month or so ago. The building programme is quite inadequate for the educational aims Great Britain has set itself. In the universities as in the schools, aims and the allocation of resources must be brought into line. If the country wishes to increase its output of scientists and technologists, it must make the appropriate allocation of steel and other supplies, or the aim must be curtailed in keeping with whatever allocation the Government is prepared to make.

On what is said in this report, and confirmed by the Advisory Council on Scientific Policy and the Technical Personnel Committee of the Ministry of Labour and National Service, some such contraction in the number of arts students and an increase in the number of students of science and technology are both practicable and desirable in the national interest, and the University Grants Committee is prepared to support it if the necessary capital expenditure is forthcoming. Clearly, as the University Grants Committee puts the point, however, the necessary provision is unlikely to be made unless the Committee is supported to the fullest possible extent by the Advisory Council on Scientific Policy, the Parliamentary and Scientific Committee and professional bodies which have been urging the expansion of higher technological education as essential to the industrial well-being of Great Britain.

With the example of the Science Centre in mind, it is impossible to be over-confident that the Government will be convinced as to the necessity of the capital expenditure, and much more tangible support must be forthcoming from the world of science and technology as well as from industry than Sir Robert Robinson's patient and strenuous advocacy received. Indeed, it might be noted here that some capital expenditure on libraries may well be essential, and there can be no question that the establishment of the Science Centre would in itself have made quite an important indirect contribution towards easing the pressure on university libraries, both by catering for the specialist and by making it easier for university libraries themselves to specialize in ways such as the University Grants Committee suggests. Furthermore, the more widely the University Grants Committee is supported in pressing for such capital expenditure and the more clearly the purpose and necessity of such expenditure is generally understood, the less the risk that university expenditure may become subject to political pressure through the failure of politicians to face the realities of the situation.

It will be noted from this survey that the University Grants Committee does not advocate or anticipate any further expansion of the university population in the near future. It inclines to the view that there is little talent capable of benefiting by a university education which does not in fact reach the university; it is concerned rather with a redistribution inside the university which will avoid waste of public money by ensuring that, since more than two students out of every three receive some assistance from public or private funds, they are trained in ways likely to be to the public advantage. It recognizes, too, that considerations of economy require that the quality should be maintained, and no students should be admitted when incapacity to read for a degree might have been detected before they entered the university at all. Likewise, by implication, it indicates the importance of awards being financially adequate, and points to the possibility of vacation employment diminishing the value obtained from a grant as well as reducing the amount of grant needed.

In such passages as this, the University Grants Committee shows itself imaginatively alive to the problems which the universities and local authorities and other bodies making awards in Great Britain must face in the interest of the economic and social background from which university students are now drawn. These are sombre facts of which account has to be taken, and more could well have been heard from the Committee regarding the quality of students and the problems that arise from the presence in the universities of relatively large numbers of students who for various home reasons have difficulty in using the vacations for academic work. It cannot be assumed without more searching and critical inquiry that the main object of a university education, namely, to fit men for responsible posts and to train them to think, is being completely realized. The complexities of a technological age require that the affairs of State shall be handled with justice, skill and magnanimity no less than when Milton formulated his idea of a complete and generous education or Mill insisted that professional men should carry away with them from a university, not professional knowledge, but that which should direct the use of their professional knowledge and bring the light of general culture to illuminate the technicalities of a special pursuit.

The universities and the University Grants Committee, as this report and its predecessors over the past quarter of a century or so show, are manifestly seeking to avoid becoming detached, and to meet more effectively the changing needs of the community in which they exist. Nevertheless, it is plain that many students are working under handicaps in the way of cultural background as well as deficiencies in teaching or laboratory accommodation, halls of residence and libraries, which the economic situation has hindered the universities from remedying; such handicaps curb the imaginative consideration of the principles underlying a career that A. N. Whitehead described as the university's distinctive contribution in the preparation for an intellectual career. The significance of these difficulties is not so widely recognized outside the universities as it should be.

For such reasons a clear and authoritative statement or discussion of the purpose and character of university education is desirable. The University Grants Committee in this lucid survey indicates something of what is being done by the universities to meet these dangers and difficulties. It also suggests ways in which the universities could clarify ideas as to the functions of a university and what is expected of its alumni, as an essential preliminary to the determination of the nature and extent of the courses a university should offer. But public opinion also requires educating. It will be noted, for example, from this report, that in spite of the country's need for more technologists, the demand for technological education is slackening, as the Advisory Council on Scientific Policy noted earlier, and intending students show a marked preference for pure, over applied, science. The universities cannot provide places to which intending students are indifferent, or discourage undue specialization or honours courses, without the co-operation and understanding of both prospective student and prospective employer.

The report gives substantial reason for confidence that, in spite of a probable continuing trend towards greater accountability to Parliament on the financial side, academic autonomy will not be endangered thereby. It gives no grounds for believing that, through any lack of vision or vigour on the part of the universities or the University Grants Committee, the universities will get out of touch with the needs of the nation or become inefficient in the discharge of their responsibilities. The danger to university autonomy and to the maintenance of university standards is, however, real; but it arises from lack of public understanding, and to dispel the danger may require increasingly strenuous efforts of exposition and interpretation. This task of publicity, of educating public opinion to the real issues at stake, is perhaps one of the most important that immediately confronts the University Grants Committee. The account of its stewardship given to Parliament in the present report is no mean contribution to that end. More, however, will be required, and the University Grants Committee and the universities should be assured in that task of the support of all who value the principle of university autonomy.

ECOLOGY OF THE TROPICAL RAIN FOREST

The Tropical Rain Forest

An Ecological Study. By Prof. P. W. Richards. Pp. xviii+450+15 plates. (Cambridge: At the University Press, 1952.) 63*s*. net.

THERE has for a long time been the need for a modern account of tropical rain forests. Prof. P. W. Richards has adequately met this need if one takes into account the appendix to his title, "An Ecological Study". Not only does he include data from his own field researches in the rain forests of British Guiana, Sarawak, and Southern Nigeria, but he has also selected wisely from an extensive literature. Moreover, the book is well written, and both excess of ecological jargon and obscurities of style have been avoided without loss of scientific precision. Another pleasing feature is that it is frankly acknowledged that there are many problems connected with tropical rain forests that are not yet solved; but these problems are defined as clearly as possible and the solutions that have been proposed are fairly summarized and as fairly criticized. One may instance the theories of buttress formation (pp. 69–74) and Aubréville's mosaic theory of regeneration (pp. 49–53).

Prof. Richards very definitely proves the complexity of the ecological problems connected with rain forests. It may, however, be questioned whether the translated quotation from van Steenis (p. vi), referred to on p. 15, is either entirely logical or suggests the best practice. There are good arguments that the floras and types of vegetation of temperate regions have been derived from the much richer floras and communities of tropical climes. It does not follow that in floristic or ecological studies "one ought logically" to start with the richest, most difficult and most complicated. Much may be said in favour of starting with the poorest and (in general) simplest floras and vegetation—say, of the Arctic. This, of course, in no way diminishes the interest and importance of tropical plant life to any botanist who is not restricted in his outlook to the laboratory and arm-chair. Probably every ecologist and every taxonomist will support Prof. Richards in his plea for increased study of the tropical rain forest, for its preservation, and for a system of adequate (in situation, size and number) Nature reserves in the tropics fully protected under national or international administration. It is most convincingly shown in the postscript (pp. 404–7), under the heading "The Future of the Tropical Rain Forest", that humanity is suffering irreparable losses by the increasing destruction of tropical rain forests. It is not only the ecologist who will bemoan the losses, but also the taxonomist, the geneticist and, in the not too distant future, the exploiters, or their would-be successors, themselves.

It is impossible in a review of reasonable length adequately to survey the vast amount of information presented in "The Tropical Rain Forest". An introductory chapter defines the community by its general characters and outlines its history. The main body of the book is in sixteen chapters classified under six parts: structure and physiognomy; the environment; floristic composition of climax communities; primary successions; tropical rain forest under limiting conditions; and man and the tropical rain forest. Only a selection from the many interesting subjects dealt with in these 'parts' can be referred to here.

A great advance in method of study of rain forests was the use of the profile diagram, and the stratification, clearly shown in profile diagrams from forests in Asia, Africa and America, is discussed in detail (pp. 22–38). The trees constituting the bulk of the rain forest show many structural and developmental features, some of which are more or less clearly of selectional value under the given environmental conditions. This is also true for the shrubs, the climbers, the ground herbs, the stranglers and the epiphytes. The general controlling factors of the habitat are climatic: "high and very even temperature and heavy rainfall spread over the greater part of the year" (p. 135). As in other forest communities, the forest modifies climatic conditions within itself, with the resultant formation of microclimates. These involve all the climatic factors and are of very great importance for forest plants of all kinds, but especially for those below the highest or densest canopy layer. Many readers will find the chapter (pp. 191–204) on seasonal changes in the rain forest of particular interest. The environment is seasonally relatively uniform, and the text of the chapter is "Though the vegetation as a whole may show hardly any seasonal rhythm, the individual plants are seldom uniformly active". Leaf changes, growth and cambial activity, and flowering—that is, both vegetative and reproductive behaviour—vary with greater or less regularity from species to species. There is even periodic behaviour recorded for forest agarics by Corner in southern Malaya. The soils of the humid tropics are said to vary in structure, and in their physical and chemical properties, at least as much as those of any other climatic zone. The soils are, except the most immature, strongly leached. Laterization, the preferential leaching of silica from a soil, results in the formation of the lateritic red earths that may be the most widespread soil-type in the tropical rain-forest region. Sometimes very different soils are formed when the influence of the soil-forming material overrides that of the climate.

The composition of climax communities is illustrated in some detail from Prof. Richards's own studies in British Guiana and Sarawak. The recolonization of Krakatau is taken as an example of a primary xerosere (pp. 269–280), and hydroseres and coastal successions are considered in more general terms.

In dealing with the conditions limiting rain forest, deciduous forest and savanna have to be contrasted with it, both as regards their floristic and ecological structure and the environmental conditions favouring or limiting one or another community. The problems involved are of "bewildering complexity", but the conclusions reached (pp. 344–5) give a clear and fair summary of what is the best generalization with our present knowledge. Chapter 16, dealing with the tropical rain forest at its altitudinal and latitudinal limits, raises the many problems of zonation and provides numerous data to be considered in reaching their solution.

Man has destroyed large areas of virgin or primitive rain forest. Where cultivation is not continuous, secondary and deflected successions occur. Apparently, little close study and systematic observation have yet been carried out on these communities, and continuous observations over a long period of years are needed. However, the general features of secondary rain forest and its composition and origin are outlined, and incomplete descriptions of secondary successions are given for Nigeria, the Congo, the Malayan region and tropical America.

"The Tropical Rain Forest" will be a stimulus to further research. Prof. Richards would be among the first, and best qualified, to say that there is need for as many investigators as possible. It is important to remember that his book is "an ecological study" or, better, a plant ecological study. Apart from vegetational problems of the rain forest known but not solved or even still unformulated, there are many others to which this book must, in some degree, form a background. The floristic composition and the history of the rain forests are considered in connexion with the ecology, not as subjects *sui generis*. The historical relationships of the American, African, Asiatic and Australasian divisions of the 'panformation' of tropical rain forests raise unnumbered questions. The animal life of rain forests is a vast subject linked to the plant life. The tropical rain forest is not the only plant formation of the tropics. In particular, one would welcome a study of tropical savannas as full and as up to date as that now provided in this book.

For no very clear reason the book is dedicated to "The memory of Carl Schroeter". Carl Schroeter was a pioneer in ecological studies of Central European vegetation in particular and mainly, and I cannot recall that he did noteworthy work in connexion with the tropical rain forest. There is no reference to a single work by Schroeter in the sixteen pages of references provided by Prof. Richards, though he is once quoted in the text (p. 10) at second-hand. One might have thought that a dedication to, say, A. F. W. Schimper would have been more appropriate.

In conclusion, this is a most important book to ecologists, plant geographers and taxonomists. It can surely be read with enjoyment and profit by all botanists and by many who would not claim a special knowledge of plant life. It is not merely a book of reference or a text-book or a tome to be interpreted only by specialists. It will be often referred to, it will be read by university students, and it will be frequently consulted by specialists. In addition, it is a book that can either be read straight through as an occupation with mental gain for many evenings or one that can be delved into, for most of the chapters, and even sections of chapters, are so far self-contained as to be fully understandable and, in a sense, complete in themselves. W. B. Turrill

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TREATISE OF ZOOLOGY

Traité de zoologie

Anatomie, systématique, biologie. Publié sous la direction de Prof. Pierre-P. Grassé. Tome 1, Fascicule 1: Phylogénie; protozoaires, généralités; flagellés. Pp. xiii+1071. (Paris: Masson et Cie., 1952.) 9,600 francs.

THIS is another volume of the now well-known "Traité de Zoologie", issued under the editorship of Prof. Pierre-P. Grassé, of the Sorbonne. While the seventh to appear, it is in fact the first fascicle of the first volume of the series and is in every way worthy of its predecessors. Its 1,071 pages are provided with 829 illustrations (there is no Fig. 285), 694 in line-drawings, 116 in half-tone from wash drawings, 18 in half-tone of photographs and 1 in line and colour. The last is so effective that it is somewhat surprising that this technique has not been employed more often. This figure has a disadvantage in that the reference letters in the legend are not alphabetically arranged, *Ect.* in the figure is given as *Et.* in the legend and two reference letters in the figure are not explained. The figures, as in previous volumes, reach a high standard and some of the line-drawings are exceptionally good. As before, a number of authorities have contributed to the contents. Since it is the first volume and deals with certain groups of the Protozoa, Prof. Grassé contributes a good deal. The other contributors, Prof. L. Cuénot (Nancy), Prof. E. Chatton (Sorbonne), who unfortunately died before all his sections were completed, M. G. Deflandre (National Scientific Research Centre, Paris), Prof. A. Hollande (Algiers) and Prof. J. Pavillard (Montpellier), are sufficiently distinguished in their own fields to assure the authority of their individual contributions.

The volume commences with a general discussion on the evolution of the animal kingdom with the view of devising a scheme of classification; this, as might be expected from the editor, is a thoughtful and useful essay. Fig. 4 on p. 23 presents a schematic classification of the whole animal kingdom in the form of a phylogenetic tree. On the whole, this is acceptable but is open to criticism on a major and at least one minor point. The major point concerns the position of the Platyhelminthes and Nematoda. The tree divides into two main trunks, one containing the Echinodermata, Protochordata and Chordata, and the other all the remaining animal groups. The division takes place as from the Cœlenterata, and the Platyhelminthes and Nematoda are regarded as cœlomates (pp. 18, 25); the more modern view is that these two phyla are not to be regarded as cœlomates that have had their cœlom obliterated or afterwards modified but rather as phyla that have not yet reached the stage of evolution in which a cœlom has made its appearance. They are acœlomate, triploblastic Metazoa. The minor point is the interposition of the Carnivora between Cheiroptera and Primates.

The editor next discusses the position and classification of the Protozoa and directs attention to the difficulties they present. He has gone back to the old name Protista, given by Haeckel in 1866, and recognizes a Phylum Protista which includes both the branches (*embranchements*), Protozoa and Protophyta, which cannot be clearly separated from one another. He employs the term phylum in a higher ordinal sense than is general in Britain, for he recognizes only two phyla of animals—the Protozoa and the Metazoa—and so his term *embranchement* corresponds more closely with our phylum. Transposing the terms in this way, he divides the Protozoa into five sub-phyla as follows: the Rhizoflagellata containing the more general Rhizopoda and Flagellata, again combining them because of the overlap; the Actinopoda (Acantharia, Radiolaria and Heliozoa), the 'pseudopodia' of which are of a fundamentally different type from those of the rhizopods; the Sporozoa; the Cnidosporidia; and the Ciliata. While perhaps this classification may not meet with general acceptance since it differs so noticeably from what may be called the orthodox, it is logical and deserving of careful consideration in view of the arguments put forward in support of it. What may surprise most general zoologists is the transference of the opalinids from the ciliates to the flagellates.

The present volume deals only with the general introductory matters and the sub-phylum Flagellata. The introductory accounts of the structure, physiology, nuclear behaviour, life-cycle and biology of the various categories form a valuable part of the work. Under the systematics of each class there is, wherever possible, a section dealing with its fossil members, a reminder of the present interest in microfossils. It is regrettable that the exigencies of the times are reflected in the price, for this highly commendable book should be readily accessible to every zoologist.

C. H. O'Donoghue

HYDROGRAPHY IN FISHERIES RESEARCH

Hydrography in relation to Fisheries

Being the Buckland Lectures for 1938. By Dr. John B. Tait. Pp. xii+106. (London: Edward Arnold and Co., 1952.) 7*s*. 6*d*. net.

THE Buckland Lectures are given each year to varied audiences by a scientific worker engaged in fisheries research. Before the 1938 series, the Lectures had been given by biologists or zoologists; the series just published differs in that Dr. J. B. Tait makes his contribution as a physicist interested in the sea itself rather than in its animals. An introduction explains the subject of hydrography (or physical oceanography) and, with examples, justifies the existence of a hydrographer in a fisheries laboratory.

In Chapter 1 Dr. Tait discusses the effects of physical conditions in the sea upon fishes. He deals at length with the part played by temperature in determining the geographical distribution of the various species and collates the results of many workers in this field during the past fifty years. Evidence that spawning is stopped by abnormally high or low temperatures is given, and this is followed by a table listing the ranges of temperature, salinity and depth in which the various species of fish are found. Once the fish have spawned, the rate of development of eggs is largely influenced by the water temperature; for example, herring eggs hatch in under a week at 14° C., but would take about seven weeks at 0–1° C. Growth of the larvæ similarly is more rapid at the higher temperatures; off the east coast of Scotland spring-born herring grow in length and weight more quickly than those born in August and September. Before leaving the influence of temperature on adult fishes, Dr. Tait mentions the exceptionally cold winter of 1928–29 during which large numbers of fish were killed by the extreme conditions. These facts were corroborated during the early months of 1947 in similar conditions. The effects of salinity, light intensity, viscosity of the sea water, and osmosis are briefly discussed.

One of the most interesting aspects of hydrography is the study of currents in the sea. Dr. Tait mentions several approaches and then gives a fairly comprehensive account of his own work with drift-bottles in the northern North Sea and adjacent regions. The manner in which the information accruing from the recapture of bottles is used by the scientific worker in constructing a picture of the current systems over wide areas is described. The importance of a knowledge of these systems is stressed and illustrated with many examples, one of which is the controversial question of fish migrations. The most widely accepted theory suggests that migrating fish swim against the current, and is apparently supported by the movement of eels in the Atlantic Ocean, of cod near Iceland, and of plaice in the Shetland Islands area, to quote the text. Dr. Tait adds that "as the knowledge of currents grows in detail, so will this theory receive the greater confirmation".

In Chapter 2 the reader is taken into the chemical department of the hydrographer's laboratory. He is introduced to the difficulties in analysing sea water and to the importance of such characteristics as hydrogen-ion concentration. In the sea where the concentration of the nutrient salts approaches, and often falls below, the limit required by marine organisms, it is obviously desirable to measure these concentrations; chemical oceanographers have worked out methods to estimate the number of parts of these elements per thousand-million parts of sea water, and the effects of their variation on fisheries can now be studied.

In his last chapter, Dr. Tait relates fluctuations in the abundance of fishes to hydrographical conditions in their environment. A diagram showing sea temperature and monthly catches of haddock would appear to indicate a complete explanation of the varying catch; but, as stated, the solution is not so simple. Dr. Tait presents the outline of his argument for the relation between fishery fluctuations and the incursions of Atlantic oceanic water into the North Sea. Although obviously aware of the scarcity of suitable hydrographical data, he finds support in a similar environment in the English Channel. It is interesting to read a note appearing in *World Fishing* of January 1953: "Reports from the Baltic indicate that the salinity there has increased considerably in recent years. As a consequence, the inflow of cod has been better and, although previously cod did not appear in Finnish waters, Finnish fishermen are now obtaining reasonable catches".

In closing, Dr. Tait would welcome more systematic and intensive measurement of hydrographical factors; but it will be apparent to all readers of his book that important steps have been made in spite of the difficulties in observing at sea.

David Vaux

THE UNIVERSITIES OF GREAT BRITAIN: POSITION AND PROSPECTS

TO assist the Treasury in considering the provision which Parliament should be asked to make for the next quinquennium, the University Grants Committee early last year issued an interim report on university development in Great Britain during the four years 1947–51. That interim report largely dispelled misgivings currently entertained as to the effect of economy measures on university development. The complete factual record for the whole quinquennium of the use to which the universities have put the greatly increased financial resources which have been at their disposal now available* is no less reassuring. Following the lines of earlier reports, the present one reviews the whole of the quinquennium 1947–52 and discusses some of the principal problems of general policy with which the universities are currently confronted. In general, it confirms the impression given by the interim report, material from which is freely repeated, that the main task of the universities during the coming quinquennium will be that of consolidating the ground won by the advances of the past five years.

The broad features of the situation have been made generally familiar not only by the interim report but also by current and continuing discussion on the expansion of technological education, the training of scientists and administrators, the control of public expenditure and the relations between industry and the universities in Britain. The work of the University Grants Committee continues to grow, and it is now concerned with eighteen universities and four separate university colleges, as compared with sixteen and five, respectively, at the beginning of the quinquennium, and two colleges of technology, although the charter as a university obtained by the University College of Southampton did not take effect within the quinquennium under review.

Looking first at student numbers, during 1951–52, the last year of the quinquennium, the number of full-time students enrolled in the universities and colleges was 83,458, compared with 78,507 in 1947–48, 66 per cent greater than in 1938–39, the last year before the Second World War, and only two thousand less than the peak figure (85,421) of 1949–50. Apart from the temporary increase due to the influx of ex-service men and women, assisted by the further education and training scheme, these numbers reflect a permanent increase which indicates the extent to which the universities have already responded to the demands for more graduates formulated in the Barlow and other reports. There were during 1951–52 twice as many students of science and technology as there were during 1938–39. Arts students increased by 60 per cent, students in agriculture by 132 per cent, medical students by 17 per cent, dental students by 94 per cent, and veterinary students were nearly four times as numerous. The expansion in science and technology was thus completed in five years instead of the ten contemplated by the Barlow Committee; but the objective of the Teviot Committee has not been reached, chiefly because numbers of suitable students have not come forward. The consequent changes in the total student body are shown in Table 1.

* University Grants Committee. University Development, Report on the Years 1947–1952. (Cmd. 8875.) Pp. 93+8 plates. (London: H.M.S.O., 1953.) 3*s.* 6*d.* net.

The University Grants Committee pays tribute to the resourcefulness and adaptability which the universities displayed in coping with these increased numbers, and notes that inconveniences of overcrowding were willingly endured in the hope, so far unfulfilled, that a rapid increase in the rate of university building would soon become possible. This still appears to be unlikely, and the experience of these years obviously determines the Committee's attitude to the further expansion of the student population. It is concerned, above all, to maintain standards, and the Chancellor of the Exchequer is reminded very firmly that any increase in the number of students of science and technology involves capital expenditure on buildings and equipment, even if the number of arts students fell at the same time.

The increase in student numbers during the quinquennium was not spread evenly over the universities and colleges. For England as a whole, the figures for 1951–52 were 70 per cent above those for 1938–39; but at Oxford and Cambridge the increases were only 41 per cent and 34 per cent, respectively, and at London no more than 39 per cent, compared with an average of 127 per cent for the remaining English universities and university colleges. In Wales the increase was 75 per cent, and in Scotland 49 per cent. Students with homes in the United Kingdom increased in number by 71 per cent, the number from overseas increasing by 33 per cent (from 5,213 to 6,960), or just over 8 per cent of the student population, compared with 10 per cent in 1938–39, more than half still coming from countries within the British Commonwealth and 57 per cent going to Oxford, Cambridge or London, compared witn about 66 per cent before the War.

The University Grants Committee thinks that there are good reasons for assuming that the rapid rate of increase in total student numbers which marked the immediate post-war period is likely to be followed by a slight fall during the next few years. Practically every university institution has been full to, or beyond, its reasonable physical capacity, and even if university institutions were themselves willing to accept any substantial increase in student numbers without the addition of new buildings on a scale unlikely to be possible immediately, the University Grants Committee is clearly and rightly opposed. "The quality of education cannot but be affected by the surroundings in which it is given and it would not be in the interest of university education that the discomforts and handicaps of overcrowded and makeshift accommodation should be endured for an indefinite period." It appears to lean rather to the view that the right policy at the present juncture may be to relieve congestion by contracting slightly the intake of students, particularly if it is true that

Table 1. Full-time Students in Faculties

	1938–39		1951–52	
	Number	Per cent	Number	Per cent
Arts	22,512	44·8	35,936	43·1
Science	7,767	15·5	17,053	20·4
Technology	5,288	10·5	10,215	12·2
Medicine	11,883	23·6	13,910	16·7
Dentistry	1,488	3·0	2,889	3·5
Agriculture	1,043	2·1	2,418	2·9
Veterinary science	265	0·5	1,037	1·2

few school-leavers who desire, and are capable of profiting by, a university education, would fail to gain admission, provided they are prepared to go to an institution other than that of their first preference. That policy is supported by other considerations noted in the report, and implies that any further increase in the student population of the universities should wait on an increase in the output of suitable pupils from the secondary schools.

The University Grants Committee does not, however, rule out the desirability of changes in distribution between faculties. It is doubtful whether the future demand for arts students will be sufficient to absorb the entire output of the universities at its present rate, and there are certain fields of vocational training, notably science teachers, dentists and some categories of scientists and technologists, from which a substantially higher output is urgently desirable in the national interest. It infers accordingly that, during the next quinquennium, the proportion of students engaged in scientific and technological studies will tend to grow at the expense of the proportion of arts students. Reference has already been made to the financial implications of such a transfer; but so far as recurrent expenditure is concerned, the Committee is reasonably confident that such adjustments of the balance of the faculties as the needs of the next few years may dictate will not be unduly hampered by lack of income. Furthermore, the Committee, pointing to the difficulty of assessing demand for specialized fields like the branches of biology, where in any one year the demand may be very small, suggests that employers requiring men with this kind of training should consider selecting them before they commence post-graduate training, paying the selected individuals' salary and fees for that training. Moreover, figures indicating the pressure to enter the various faculties afford little support for the view that men choose the faculty in which they would propose to read mainly by reference to the salaries to be expected on completion of training.

Reviewing the numbers of students in relation to population, the report notes that, assuming the survival of 90 per cent of live births to age eighteen, the proportion of any age-group which reaches the university is now about 1 in 31 compared with about 1 in 60 before the War. As the annual number of live births in Great Britain began to rise steeply in the latter part of the War, reaching a peak average of 932,000 in 1946–48, a marked increase in student numbers will be required from about 1960 onwards if the proportion of each age-group which reaches the university is to be maintained. Broadly, it appears to be true to say that the differences between England, Wales and Scotland in the proportion of any age-group which reaches the university have greatly diminished. While the Committee thinks that to aim at raising the university student population to the American scale by lowering entrance standards to that of the American college would be unwise and would alter the whole character of our universities, it would welcome an increase in the student population subject to three conditions: first, there should be no increase in any faculty that would lead to difficulties in finding satisfactory employment for its graduates; secondly, the necessary additions to accommodation and equipment should be forthcoming; and third, it should involve no decline in the standard reached by students when they obtain their first degree.

This last condition probably means that if the other two were satisfied and the time were ripe, until the rise in the birth-rate takes effect, the increase could only come through the retention in the grammar schools of a greater proportion of the more intelligent pupils who now leave prematurely. The report also directs attention to the change in the economic and social background of the students which has occurred during the past two or three decades. Whereas the percentage of all full-time students receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds in 1938–39 was 41·1, in 1951–52 it was 72·4, and at one stage the proportion at Oxford and Cambridge rose as high as 82·2 and 79·8 per cent, respectively. The position is further displayed in Table 2, and it should be further noted that the number of unassisted students has declined absolutely, as well as relatively, from 29,456 in 1938–39 to 23,006 in 1951–52, almost entirely in Oxford, Cambridge and London.

Table 2. Assisted Students as a Percentage of all Full-time Students

	1938–39	1951–52
England		
Cambridge	39·0	67·8
London	26·0	67·7
Oxford	55·2	71·7
Other universities and university colleges	44·4	79·5
Total		
England	38·5	73·8
Wales	61·4	88·3
Scotland	45·1	61·6

One consequence has been that a much higher proportion of students than formerly are young men and women who have few cultural interests and attainments beyond those which they have acquired at school. Their presence in the universities has forced upon the universities various problems of teaching and the organization of student life which were not previously generally recognized, and the solution of which may be assisted by the fact that the academic staff are increasingly drawn from the same strata of society as the students.

As regards quality of students, it seems that in relation to the total number of students, the proportion of outstandingly good and outstandingly weak students is lower, and that of good second-class students higher, than it used to be. There is probably also a continuing tendency for a higher proportion of the abler school-leavers to seek admission to the scientific faculties; but the demand for technological courses is less keen than that for pure science. Despite the reassuring impressions of student quality derived from the Committee's visits to universities, its general conclusion is that no further substantial increase in student numbers could be expected in the immediate future without reducing university standards. It is not disturbed by present casualty-rates, but would deplore alike any tendency to admit to a first year of study students whose incapacity to read for a degree could have been detected before they entered the university at all, or to regard the award of a degree as automatic once admission to a university is granted. Nevertheless, the University Grants Committee thinks that in general the problem of selection is receiving the attention it deserves. It considers that the response to steps taken to stimulate wider interests among students has been most encouraging; but it gives a caution about vacation employment

and suggests that the question of vacation study may require further attention.

Although a few new university halls of residence have been erected during the quinquennium, the addition of 7,500 places since 1938–39 has done little more than maintain the pre-war proportion of students in residence. This is one of the outstanding disappointments of the past quinquennium; but in accepting the fact that there is little prospect of any immediate and considerable expansion of the residential system, the Committee does not wish to discourage universities from thinking ahead to a period when building on a larger scale can be resumed. It points out, however, that the extent to which students should reside in halls can be over-stated, and that residence in hall is not necessarily the best arrangement for every student at every stage of his career. Further, it is desirable meanwhile to do all that is possible to develop other agencies for promoting communal life and to keep students in the university atmosphere at times when they are not required to be in attendance at lectures. As regards student health, it is suggested that provision for this requires reconsideration in the light of the general principle that university schemes should aim at satisfying the special and distinctive needs of student life rather than providing a duplication of the National Health Service.

While the increase in students came early in the quinquennium, the increase in academic staff, from 3,994 during 1938–39 to 5,561 during 1946–47 and 8,952 during 1951–52, came later. It was not until the later years of the quinquennium that the flow of suitably qualified candidates enabled the universities to recruit new staff in sufficient numbers to meet the needs of the enlarged student population; but the staff : student ratio (excluding Oxford and Cambridge, for which comparable figures are not available) has risen from 1 : 10 in 1938–39 to 1 : 8 in 1951–52. Nearly all the universities and colleges in Britain have been able to develop to some extent a tutorial system, particularly for the benefit of their senior students. The Committee believes that the doubling of the academic staffs has not involved any deterioration in quality; but it points out that the full financial effect of this expansion has not yet been felt, and the low average age of the academic staffs in most universities has repercussions which require attention in recruitment policy in the creation of new posts, such as readerships, and in considering the age of retirement, if serious promotion blocks are to be avoided. The report gives a clear account of the present salary position and of the unavoidable differentiation between medical and non-medical staff. It stresses the importance of an improvement in the staff : student ratio; but while fully supporting the view that the university teacher should be able to devote an adequate proportion of his time to research or other original work, it deprecates any idea that the potential value of a young member of a university staff can always be judged by his or her output of research or scholarship before the end of three years service as an assistant lecturer.

More is said about research in the following section of the report. The University Grants Committee does not believe that there is any immediate danger in Great Britain of the universities devoting an undue share of their research activities to the fulfilment of government contracts. In the years ending July 31, 1950, and 1951, the universities received from government departments and the research councils, for specialized research, including some capital, £1·6 million and £1·7 million, respectively, compared with a total revenue expenditure of the universities in these years of £22 million and £24 million, respectively. On the other hand, it is pointed out in regard to nuclear research that, while this is a continuation of a field of investigation which was attracting many notable physicists before the War, and it is desirable both that some university research workers should have access to the large machines provided at such universities as Cambridge, Oxford, Birmingham, Liverpool and Glasgow, and that a proportion of those undertaking physics research in other universities should devote themselves to nuclear investigation, it would be unfortunate if preoccupation with this particular branch of physics were to distort the general balance of research. The Committee states that it does not propose to continue, in the quinquennium 1952–57, the practice of recommending non-recurrent grants for the purchase of new equipment for existing accommodation, though such grants will continue to be available, as may be necessary, for furnishing and equipping new accommodation. Of non-recurrent grants for this purpose during the quinquennium, totalling £7 million, some was for bringing the equipment of existing laboratories up to an appropriate level, and the Committee believes that the average scientific worker in the university is now far better equipped for prosecuting his research activities than at the beginning of the quinquennium.

The Committee refers to the importance of avoiding overloading of the curriculum for a first degree and urges that in designing such courses of study the consideration that universities have to educate men and women capable of holding positions of responsibility in every walk of civil life should always receive its due weight. Students of all levels of ability will derive benefit from their courses only if they learn to think. Reference is also made to the inquiry into ways of learning by students of university age which the Committee is sponsoring by an *ad hoc* grant; and while welcoming the increased allocation to libraries proposed in the quinquennial estimates of many universities, the Committee also stresses the value of the possession of even a small private library. Expenditure by university libraries on the purchase of books and periodicals has risen from £87,802 during 1938–39 to £321,269 during 1951–52; but great difficulty is constantly experienced in meeting the legitimate demands of students and staff. Moreover, pressure on space has developed from increased buildings as well as from the increase in readers to be served, and the report holds out little prospect of any early alleviation of the position by new building. The suggestion is made that university libraries may need to be highly selective and that the possibilities of 'weeding' should be fully exploited. The Committee has also decided to terminate the ear-marking of grants, and has informed the universities that while it does not propose that any part of the recurrent grants for the new quinquennium should be formally ear-marked to support developments in the special fields which were initiated during the past quinquennium, it has taken this step on the assumption that in allocating their income the universities will treat the developments of the 1947–52 quinquennium in these fields no less favourably than other departments. The Committee has asked any university which proposes to curtail any development initiated with the aid of an ear-marked grant to consult the

Table 3

	1947–48	1948–49	1949–50	1950–51	1951–52
	£	£	£	£	£
Total recurrent (including ear-marked) grants	8,850,455	10,317,775	13,635,470	15,222,408	1,660,113
Medical education	1,840,350	2,149,800	2,565,500	2,885,000	3,198,500
Dental education	157,150	206,000	237,000	268,000	300,000
Agricultural education	150,000	262,000	299,500	327,850	361,600
Veterinary science	12,500	28,800	116,800	276,750	412,500
Social studies	102,000	160,000	240,000	320,000	400,000
Oriental and African studies	55,000	125,000	148,500	173,000	200,000
Slavonic and East European studies	15,225	30,975	36,875	42,825	49,800
Institutes of education	20,230	79,570	131,994	155,499	171,463
Ear-marked grants as a percentage of total grants	26·6	29·5	27·7	29·2	30·7

Committee before a final decision is taken. The totals for each year of the quinquennium of the recurrent grants allocated and of the ear-marked grants for each special field are given in Table 3.

Non-recurrent grants approved in the period August 1, 1947–July 31, 1952, amounted to rather less than £35 million, as compared with the estimate in January 1947 of capital needs for the quinquennium of £40 million for new building and £10 million for sites and equipment, or about half the capital expenditure regarded as required, at 1947 prices, to give effect to the Barlow report over ten years (instead of the actual five in which the expansion was realized). Of this sum, £23 million was in respect of building, more than £4 million for the purchase of sites and properties and £7 million for provision of furnishings and equipment. Actual payments during the quinquennium totalled £26 million, and at its close more than £11 million of approved grant awaited payment. Some indication of the way in which the universities have met the situation arising out of the reductions in the investment programme and the rationing of steel by adapting their building programme is given by illustrations included with the report.

The outstanding feature of university finance during the quinquennium has been the increase in the proportion borne by recurrent Treasury grants to the total income of the universities, from 31·4 per cent in 1938–39 to 64·5 per cent in 1951–52. The original and ultimate Treasury provision for each year in the quinquennium is shown in Table 4.

Income derived from local authorities in England and Wales increased by 50·9 per cent, from £626,947 during 1946–47 to £945,972 during 1951–52, that from tuition and examination fees increasing from £3,022,634 to £3,807,440, while in the same period "Other income" increased by 113 per cent, from £910,032 during 1946–47 to £1,936,596 during 1951–52. Annual expenditure rose from £12,694,227 to £26,132,122, almost half of this being due to the increased cost of salaries and superannuation

Table 4

	Academic year				
	1947–48 £m.	1948–49 £m.	1949–50 £m.	1950–51 £m.	1951–52 £m.
Original provision	9·00	9·97	10·62	11·27	11·92
Additions for :					
Medicine	—	0·02	0·28	0·44	0·60
Social studies	—	—	0·05	0·10	0·15
Agricultural education	0·15	0·28	0·30	0·33	0·38
Veterinary education	0·01	0·03	0·12	0·28	0·41
Salary supplementation	—	0·31	2·28	2·86	3·19
University College of North Staffordshire	—	—	—	0·05	0·06
Ultimate total provision	9·16	10·61	13·65	15·33	16·71

of teaching staff, which rose from £5,956,248 during 1946–47 to £12,542,994 during 1951–52, the average salary of a full-time university teacher increasing by about 32 per cent. Other expenditure rose from £6,737,979 to £13,589,128 or 102 per cent, that under the heading "Departmental and Laboratory Maintenance", which was more severely affected by rising prices than that under any other head, accounting for £3,174,295 of this increase. Maintenance of premises increased by 98·5 per cent and administration by 94 per cent, due partly to increased staff required by the higher level of university activity, partly to salary and wage increases and partly to increases in prices, notably in paper and printing.

Some remarks are made on particular fields of study. Regret is expressed, for example, that little appears to have been done to carry out the recommendations of the Goodenough Committee for lightening the medical curriculum, and also that in some institutions the course for a degree in dentistry appears to be longer than is necessary. The arrangement by which, with the co-operation of the general practitioners in the area, students receive during part of their clinical period instruction directly related to the conduct of general practice is commended for imitation.

A statement of the additional science subjects for the development of which block grants have been given is appended to the report, and the Committee is satisfied that the only major subject in which additional facilities appear to be required is biochemistry. In regard to technology, it observes that in the universities as a whole the demand for entry into technological faculties from students of acceptable standard is not greater than the universities can meet, but entry into science faculties has continued in most places to be more competitive. While agreeing that the number of those taking technology in the universities should be increased, the Committee does not advocate a uniform increase in all faculties of applied science or technology, or that technologists should constitute a similar proportion of each university. It suggests rather seeking to increase the number of students of technology in those universities where it is already high, on the ground that it is most economic to make provision for subjects in which large and expensive apparatus is required in a few centres. It is convinced, however, that scarcely any centre can cover the full range of technological subjects, since the activities of an institution must be in part related to those of the area which it serves. On management, it suggests that any course which teaches a man to think, broadens his mind and develops his personality, fits him for a position of responsibility ; but otherwise education for management is best concentrated in postgraduate courses.

THE BRITISH INSTRUMENT INDUSTRIES' EXHIBITION

THE second exhibition of the British Instrument Industries was held during June 30–July 11 in the National Hall, Olympia, London, two years after the first. It is the intention of the sponsors—five trade associations concerned wholly or partly with instrument manufacture—and organizers to make the exhibition a biennial event.

The confidence in the value of the exhibition shown by these plans seems to be justified: the second exhibition had more exhibitors than the first; the exhibitors, numbering 168, represented adequately the British instrument industries and included most of the large firms and many of the smaller ones; and the products displayed (of 414 kinds, according to a count of the subject headings of the classified index in the catalogue) were representative of the scientific and industrial instruments made in Great Britain. The hall, which was well set out, appeared to be comfortably filled and the exhibitors busy.

The instruments on show, too numerous to be described individually, revealed one general and well-recognized trend and several local and less obvious ones. The general one is, of course, the increasing extent to which almost every type of modern instrument incorporates, and is dependent upon, electrical or electronic components or accessories, which are therefore expected to be almost as reliable and trouble-free as the cases and stands themselves.

Apart from this general trend, some small but probably significant changes are discernible. Thus there appears to be an increasing number of instruments made for non-destructive testing, and particularly for thickness gauging, with special emphasis on the measurement of the thickness of electro-deposits and coats of paint. The application of radioactivity is becoming more common and new uses are being found: one exhibit was an ionization anemometer, where the rate at which air ionized by a radioactive source is blown away provides a measure of wind velocity. Strain gauges are becoming ubiquitous research tools, and are taking on new forms, incorporated, for example, in compact, hermetically sealed load cells.

Some of the exhibits provided encouraging evidence that there is not always as long a delay in developing commercial models of instruments from the products of the research laboratories as is often supposed. The flying-spot microscope, the possibilities of which were pointed out by Roberts and Young as recently as 1951 (*Nature*, **167**, 231; 1951), was on show (not for the first time) and was no longer regarded by visitors as a novelty. Recent work on the production of transparent conducting coatings on glass for de-icing instrument windows or preventing static charges from building up on them has already borne fruit in commercially available indium, cadmium oxide, and gold coatings on glass squares with light transmissions up to 90 per cent (indium) and resistances from 5,000 (indium) down to 15 (gold) ohms. This augurs well for the prospects of early development of commercial models of some of the useful prototype instruments —a simple radiometer, a capacitance-resistance hygrometer, and a voltage stabilizer, to mention three—shown on the stand of the Department of Scientific and Industrial Research by some of its establishments and the research associations.

The exhibition has brought to mind three matters which might well be given further consideration before the next one is held. First, is the word 'Celsius' to be used instead of 'Centigrade' in accordance with the International Temperature Scale adopted internationally in 1948? Many exhibitors marked their instruments '°C.'; but of those who used a complete word, only one was noticed to have employed 'Celsius'. Second, are the results of the recent work by the Naval Motion Study Unit and others on the design of dials and indicators generally applicable? Third, can substantial effort be devoted to finding means of reducing reflexion from instrument windows? With the prevalence of rows of panel-mounted instruments observed by one man who sees each instrument from a different angle and cannot, therefore, avoid reflexions from all of them by moving his head, this trouble has become serious.

OBITUARY

Dr. Tom Goodey, O.B.E., F.R.S.

Dr. Tom Goodey, who died suddenly on the evening of July 7 on his way home from a Friends' meeting, was born at Wellingborough on July 28, 1885. He was educated at the County School, Northampton, and at the University of Birmingham, where he took the degrees of B.Sc. (with honours in zoology and botany) in 1908, M.Sc. in 1909 and D.Sc. in 1915. In 1910 he was elected to the Mackinnon Studentship of the Royal Society. During the year 1912–13 he was protozoologist at Rothamsted Experimental Station and returned there in 1920 after serving during 1913–19 on the staff of the laboratory of agricultural zoology attached to the Department of Zoology at the University of Birmingham. In 1921 he was transferred by the Ministry of Agriculture to the agricultural section which the Ministry subsidized in the Department of Helminthology at the London School of Tropical Medicine. When this Institution became incorporated in the new London School of Hygiene and Tropical Medicine, the Development Commission provided the School with a field station, for the work on agricultural helminthology, at Winches Farm, St. Albans, which later became generally known under the title of Institute of Agricultural Parasitology. There Goodey worked from 1926 until 1947 and ultimately became a principal scientific officer. On the retirement of its director, those members of the staff who were engaged on research into plant-parasitic nematodes were transferred by the Ministry of Agriculture to Rothamsted, and Goodey became head of the new Nematology Department there. Although he retired from this position last year, he continued to take an active share in the work of the Department up to the day of his death.

Goodey's earlier researches were mainly concerned with the activities of Protozoa in the soil; but the investigations by which he acquired an international reputation were those on the nematodes parasitic in and on plants, and the related forms present in soil and fresh water. In 1933 he published "Plant-Parasitic Nematodes and the Diseases they Cause". This was followed in 1951 by "Soil and Freshwater Nematodes"—the first comprehensive monograph on this subject in the English language.

All his scientific writings were characterized by a clarity and felicity of expression and illustrated by a

fine series of line drawings, to the preparation of which he devoted much care and skill. His work was to him a source of continual delight. He lived a life of imperturbable serenity, deriving additional pleasure from gardening and music. He was the fortunate possessor of a fine tenor voice, which he gladly used on innumerable occasions to assist local charities and to contribute to the social life of the community in which he lived.

In 1947 Goodey's outstanding contributions to science were recognized by his election to the fellowship of the Royal Society, and those to agriculture by his appointment in 1950 to be an Officer of the British Empire.

R. T. LEIPER

NEWS and VIEWS

The Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme

THE Royal Society and the Nuffield Foundation are to initiate jointly a Commonwealth Bursaries scheme. The Nuffield Foundation is supporting this bursary scheme as a complement to its established programme of Commonwealth fellowships and other awards. The objective of the scheme is to provide facilities for increasing the efficiency of investigators of proved worth by enabling them to pursue research, learn techniques or follow other forms of study where either or both the physical and personal environment overseas in the Commonwealth is peculiarly favourable. The main difference from the ordinary research fellowship is one not merely of duration but also of emphasis, as the bursaries will aim not so much at obtaining the answer to a particular question as at improving the powers of the recipient to extend the bounds of knowledge. The scheme will be operated for an experimental period of five years during which time the Nuffield Foundation will provide £5,000 a year, and this will be devoted to bursaries to United Kingdom scientists who wish to go to oversea parts of the Commonwealth and to scientists of one oversea part of the Commonwealth to go to another. Initially the Royal Society will also make a contribution of £2,500 which will be available for movement in any direction within the Commonwealth, including to the United Kingdom. It is, however, hoped that funds may be obtained from other sources, particularly from overseas, to make possible the full development of the scheme especially by increasing the proportion of bursaries available for scientists of oversea countries of the Commonwealth who desire facilities in the United Kingdom. Each bursary will provide for the cost of travel and maintenance normally for periods of 2–12 months. It will not aim at the provision of any salary as such but will supply maintenance. The applicant must be sponsored by a recognized research authority and must produce evidence that he or she has prior permission to work in the laboratory or other scientific institution chosen. It is expected that in the operation of the scheme Fellows of the Royal Society throughout the Commonwealth will assist in sponsoring and assessing applicants for bursaries.

A joint Royal Society and Nuffield Foundation Commonwealth Bursaries Committee has been set up to administer the scheme on behalf of the sponsors. Its membership is as follows: *Chairman*, Sir Edward Salisbury; *Nominated by Trustees of the Nuffield Foundation*, Mr. Leslie Farrer-Brown, Sir John Stopford and Prof. A. R. Todd; *Nominated by Council of the Royal Society*, Prof. G. R. Cameron, Prof. H. S. W. Massey and Sir Eric Rideal, with Dr. D. C. Martin, assistant secretary, Royal Society, as secretary to the joint Committee. It is proposed initially to consider applications at six-monthly intervals beginning early in 1954. Application forms containing further details will be obtainable from the Assistant Secretary, the Royal Society, Burlington House, Piccadilly, London, W.1, and must be submitted not later than March 15 and September 15 each year.

Royal Society Research Appointments

THE Council of the Royal Society has made the following research appointments: Mr. P. J. Black (University of Cambridge) to a Mr. and Mrs. John Jaffe Donation Studentship to carry out research on the structural studies of intermetallic compounds at the Crystallographic Laboratory, Cavendish Laboratory, Cambridge; Mr. J. R. Cross (University College, Swansea) to a Mr. and Mrs. John Jaffe Donation Studentship to carry out research on the physical chemistry of cell processes at the Physical Chemistry Laboratory, University of Oxford; Dr. J. E. Falk (University College Hospital Medical School) to a Foulerton Research Fellowship to carry out research on the biochemical mechanisms involved in the production of porphyrins and hæmoglobin by animal tissues at University College Hospital Medical School, London; Dr. P. M. Holton (*née* Watson-Williams) (Physiological Laboratory, University of Cambridge) to a Foulerton Research Fellowship to carry out research on chemical transmission in the nervous system at the Physiological Laboratory, University of Cambridge; Mr. A. E. Litherland (University of Liverpool) to a Rutherford Memorial Scholarship to carry out research on fast-neutron spectroscopy at the Atomic Energy of Canada, Ltd., Chalk River, Canada (the financial provision for this Scholarship is being made by the Atomic Energy of Canada, Ltd., with whose agreement the Council of the Royal Society has conferred on Mr. Litherland the title of Rutherford Memorial Scholar); Mr. B. J. Robinson (University of Sydney) to a Rutherford Memorial Scholarship to carry out ionospheric research at the Cavendish Laboratory, Cambridge.

Paris Academy of Sciences: Recent Elections

THE following elections have been made in the Paris Academy of Sciences: Prof. L. Néel, professor of experimental physics in the University of Grenoble, to be non-resident member in succession to the late Prof. J. Haag; Prof. L. Escande, director of the Institute of the Mechanics of Fluids, University of Toulouse, to be *correspondant* for the Mechanics Section in succession to Prof. J. Leray, recently elected member of the Section; and M. A. Coutagne, consulting engineer, to be *correspondant* for the Section of Geography and Navigation in succession to the late Sven Hedin.

Presidency of the Institution of Mining Engineers: Major N. E. Webster, O.B.E.

MAJOR NOEL E. WEBSTER has been elected president of the Institution of Mining Engineers for 1954–55 and will succeed Prof. J. Cecil Mitcheson

at the sixtieth annual general meeting of the Institution, to be held in London on January 28, 1954. Major Webster, who was born in 1893, received his early training at the then University College, Nottingham, and obtained his colliery manager's certificate in 1919. During the First World War he gained first the M.C. and later the O.B.E., this latter being awarded for his services in connexion with the development of sound-ranging and flash spotting for counter-battery fire. He was for many years managing director of the Nunnery Colliery and associated companies, where he was concerned with the development and early application of mobile coal-getters for working under Sheffield. At present he is chairman of several companies connected with equipment for mine-working and the utilization of coal, and is associated with many other concerns in these lines. As one who conducted research on strata control and on the application of electrical power to mining practice, Major Webster is naturally keenly interested in the training and education of mining engineers, and, among his services in this field, he is chairman of Sheffield University Mining and Fuel Committee.

The Smithsonian Institution: Mr. Andrew Kramer

Mr. Andrew Kramer, the instrument-maker, who has produced some of the most precise instruments known to science, retired from the Smithsonian Institution, Washington, after sixty-one years service. He joined the Institution in 1892 and then worked with S. P. Langley on the latter's famous aeroplane and the models which preceded it. After that he always remained associated with the Institution's Astrophysical Observatory which was founded by Langley. Some of Abbot's well-known pyrheliometers and pyranometers, constructed by Mr. Kramer, and designed to measure extremely fine differences in solar heat radiation, are sufficiently sensitive to measure accurately the heat of a candle twenty miles away. Mr. Kramer was not merely an instrument-maker, for he understood the theory and purposes of all the instruments he made, and often suggested steps to increase their precision. His *magnum opus* was the chamber for Abbot's water-flow pyroheliometer. Mr. Kramer is eighty-four years of age. Men of science will wish him and Mrs. Kramer happiness during his retirement.

Hilda Martindale Educational Trust for Women

By the terms of the will of the late Miss Hilda Martindale, an educational trust has been set up, with capital amounting to £30,000, which will be administered by trustees appointed by Bedford College, London. The income will be used to help "girls and women of the British Isles intending to fit themselves for some profession or career, likely to be of use or value to the community, for which special training is required". Medicine, nursing, agriculture, architecture, engineering, posts in the higher grades of the Civil Service and inspectorships are some of the careers cited by Miss Martindale in her will as examples of what she had in mind. Miss Martindale's life was one of continual social service, and she was particularly interested in the welfare of children, especially in regard to the work of juvenile courts and orphanages. Educated at Royal Holloway College, London, the Royal Sanitary Institute and Bedford College, her first post was in 1901 as a factory inspector in the Home Office, and in the Civil Service she rose to become deputy chief inspector of factories and then, from 1933 until her retirement in 1937, director of women's establishments for the Treasury. After she had retired, Miss Martindale was able to devote more of her time to her two great interests—the Friendly Almshouses, founded by her great-grandmother, and Dr. Barnardo's Homes.

The Wilfred Hall Telescope

Fears which had earlier been expressed regarding the future of the 15-in. twin astrographic telescope left by the late Dr. Wilfred Hall to the Royal Astronomical Society were dispelled by the president of the Society, Dr. John Jackson, at its summer meeting in Newcastle on July 22. The Society could not have accepted the bequest, under the terms of the will, unless the telescope could be re-erected at some place at which it could be used for scientific research. The testator's intentions will be complied with by a long-term loan of the instrument from the Society to the municipality of Preston, Lancashire, which already manages the Jeremiah Horrocks Observatory. Support from the Ministry of Education will enable the telescope to be re-mounted at Preston, where, it is hoped, it will shortly enter upon a new lease of useful life.

Use of Peat for Gas Turbines in Scotland

In the course of a debate in the House of Commons on Scottish affairs on July 14, the Secretary of State for Scotland, Mr. James Stuart, stated that the report of the committee, under Sir Edward Appleton's chairmanship, which has been investigating the possibility of developing Scottish peat deposits, is in an advanced stage of preparation. Meanwhile, a specific recommendation of the committee, supported by Sir William Stanier's gas turbine committee, that the North of Scotland Hydro-Electric Board, with assistance from the Development Fund, should set up an experimental peat-burning power station at Altnabreac, Caithness, has been accepted by the Development Commissioners and the Treasury. The plant will consist partly of a 2,000-kW. closed-cycle gas turbine on which the North of Scotland Hydro-Electric Board and Messrs. John Brown and Co., of Clydebank, have been working since 1947. An oil-burning turbine of this type, the first in Great Britain, is expected to be in operation at Carolina Port, Dundee, in three or four months time. A pilot gas turbine burning dried peat has also run for a thousand hours at Clydebank with promising results, and the new peat plant is a development of this. In addition, the scheme will include a 750-kW. open-cycle turbine built to the order of the Ministry of Fuel and Power out of a grant from the Development Fund, which will be installed as soon as it has completed the necessary tests and is in full working order. The whole pilot scheme will take three to four years to complete, and the capital and development costs, estimated at about £500,000, will be met mainly from the Development Fund with contributions from the Hydro-Electric Board and the British Electricity Authority. If the scheme is successful, it is the intention of the Hydro-Electric Board to proceed to larger schemes on other suitable areas in the Scottish Highlands. It is estimated by the peat committee that about 600 million tons of peat solids are available in Scotland, in areas where depth, accessibility and other features make them suitable for utilization, and, of these, about 130 million tons are in Caithness and Sutherland.

Humicolin, a New Antibiotic

It has been shown by P. J. Curtis, H. G. Hemming and E. G. Jefferys that *Aspergillus humicola*, a fungus obtained from soil in deep caves, produces an antifungal substance to which the name humicolin has been given (*Trans. Brit. Mycol. Soc.*, **35**, Part 4, 263; December 1952). The substance is obtained by extraction of culture filtrates with charcoal, from which it is eluted with carbon tetrachloride. It is a weakly acidic yellow oil, soluble in petrol ether, contains no nitrogen, sulphur or halogen, but probably has a phenolic or enolic group; it crystallizes from methanol at − 80° C., distils at 210–215° C. at 10^{-2} mm. of mercury, is moderately stable in aqueous solution at *p*H 3·5–4·5, but is inactivated at higher *p*H values. Humicolin inhibits the spore germination of several common fungi—at concentrations ranging from 0·4 μgm./ml. for *Fusarium cæruleum* to 12·5 μgm./ml. for *Trichoderma viride*, though spores of *Absidia glauca* are not prevented from germinating by 50 μgm./ml.

Radioactive Cortisone and Hydrocortisone

A limited supply of radioactive cortisone and hydrocortisone is now available without charge to qualified investigators through funds supplied by the National Institute of Arthritis and Metabolic Diseases, Public Health Service. Both are labelled at position 4 with carbon-14. The cortisone has a specific activity of 0·49 mC./m. mole, and the hydrocortisone a specific activity of 1·47 mC./m. mole. Requests, in the form of a letter concisely describing the proposed research, should be sent to the Division of Research Grants, National Institutes of Health, Bethesda 14, Maryland, U.S.A. Transfer and use of these materials are subject to current regulations of the U.S. Atomic Energy Commission. Synthesis of these ring-labelled compounds was an international co-operative effort: the United States Atomic Energy Commission supplied the radiocarbon; Charles E. Frosst and Co., of Montreal, synthesized the radiocortisone, with help from the Upjohn Company; the Worcester Foundation, utilizing radioactive progesterone prepared by Frosst, prepared the hydrocortisone by biosynthesis.

University of Leeds

Dr. R. D. Preston, reader in plant biophysics in the University, has been appointed professor of plant biophysics in the Department of Botany as from October 1.

Dr. W. A. Sledge, lecturer in botany, has been granted leave of absence for the second term of session 1953–54, to enable him to continue researches on the fern flora of Ceylon.

The following gifts have been received: for the Clothworkers' Departments, £1,550 for 1952–53 from Courtaulds, Ltd., to be used as follows—£700 for scholarships, £600 for research in the Department of Textile Industries, £250 for research in the Department of Colour Chemistry and Dyeing; for the Department of Inorganic and Physical Chemistry, £1,500 from the Department of Scientific and Industrial Research for crystallographic computations on the electronic computer at the University of Manchester.

Swiss Society for Natural Sciences

The Swiss Society for Natural Sciences will hold its 133rd annual meeting at Lugano during September 5–7, under the presidency of State Councillor Dr. B. Galli. Medical biology will again be to the fore, with a general session on radioactive isotopes, and so will medical psychology and psychiatry with a historical session. Prof. A. Lombard, of Brussels, reporting on his 1952 Everest Mission, and Prof. G. Polvani, of Milan, speaking about Volta's notes on a journey through the St. Gotthard, will interest a general audience. The supporting section programme is fullest in chemistry, with speakers from Heidelberg, Marburg, Milan, Boston and Philadelphia. A notable communication announced in the combined programme for geophysics, meteorology and astronomy is one on echosondage of the atmosphere by Prof. J. Lugeon, of Zurich. Botanists will discuss polyploids with the zoologists and geneticists. The meeting will be followed by a visit to the electric generating station in the Valle Maggia, a botanical excursion to the Isola di Brissago, and extensive geological tours.

Announcements

We regret to announce the death on July 26 of Dr. M. H. Gordon, C.M.G., C.B.E., F.R.S., consulting bacteriologist at St. Bartholomew's Hospital, London, aged eighty-one years.

The Society of Dyers and Colourists has elected Mr. J. G. Hopkinson to be honorary secretary in succession to Mr. J. Barritt, who has resigned owing to the pressure of other commitments. Mr. Barritt will, however, continue as chairman of the editorial panel and serve the Society in other branches of its work dealing with publications. Mr. Hopkinson, who is a graduate in chemistry of the University of Oxford and has studied dyeing and textiles at the University of Leeds and Bradford Technical College, is a director of Hopkinson and Shore, Ltd., dyers and finishers of Brighouse, Yorks.

A Glaxo Laboratories Research Fellowship has been granted through the Friends of the Hebrew University to Miss Alisa Tietz, a graduate of the Hebrew University of Jerusalem, who is at present doing research in the Biochemistry Division of the Medical Research Council in London under Dr. A. Neuberger.

According to a written statement made in the House of Commons on July 15 by the Secretary of State for the Colonies on the subject of technical officers in agricultural departments of Colonial Territories, out of a full establishment of 1,270 officers serving an area of more than 25,000 square miles the number of vacancies known to the Secretary of State is 122. Seventy-seven candidates have been selected but are still in training, leaving forty-five vacancies still unfilled.

The triennial award of the Coopers Hill War Memorial Prize and Medal has been made by the Institution of Electrical Engineers to Mr. G. Lyon, for his paper on "Some Experience with a British A.C. Network Analyser". The Coopers Hill War Memorial Prize, which was founded by the members of the Royal Indian Engineering College, Coopers Hill, in commemoration of members of the College who fell during the First World War, is awarded annually by the Institution of Civil Engineers, and triennially in turn by the Institution of Electrical Engineers, the School of Military Engineering, Chatham, and the School of Forestry, Oxford. It consists of a bronze medal, a certificate and about £20 in money, and is given for the best paper on a professional subject published by the Institution during the period concerned, the award being restricted to corporate members less than thirty-five years of age.

MOLECULES OF WATER IN SOLIDS

A CONFERENCE was held in Paris during June 24–26 under the auspices of the Centre National de la Recherche Scientifique, supported by the Rockefeller Foundation. The conference was the fifty-third in the series of discussions organized by the Centre National, and, as in previous conferences, it was limited to about twenty specialists. The full title of the discussion was "The Study of Molecules of Water in Solids by means of Electro-Magnetic Waves (from X-Rays to Radiofrequencies)". All the meetings except the last were held in the Institut de Chimie-Physique, of the Sorbonne, Paris, and the last session was held in one of the laboratories at the Château Gif. The following topics were discussed: (*a*) crystal structure and the physical properties of hydrates; (*b*) dielectric constants and dielectric absorption as a function of frequency and temperature; (*c*) infra-red spectra due to H_2O and OH groups; (*d*) Raman spectra; (*e*) magnetic resonance.

The papers presented at the conference showed that considerable advances are being made in the study of the water molecule in crystalline hydrates. Among the new techniques should be mentioned nuclear resonance and Raman spectra. The interaction of the protons within each water molecule makes it possible to determine, with a precision of a few degrees, the direction of the line joining the protons. Magnetic resonance measurements can also frequently afford a reasonably accurate measure of the distance apart of the protons. However, no information can at present be gained by this method concerning the relative positions of the oxygen and hydrogen atoms within any one molecule. Even with this limitation, the new method is complementary to the methods of X-ray crystallography, which are primarily useful in fixing the position of the oxygen atoms. The frequencies of the Raman spectra are determined by the modes of vibration of the water molecule and the polarization of the Raman lines by the orientation of the molecule. When the mode of vibration can be identified by the frequency and when the crystal structure is not too complicated, it is possible to determine the direction of the OH bonds. This, too, is information complementary to that obtainable by X-rays. A present limitation on both these methods is the large size of crystal required.

The advances made using the older methods are due to the greater detail in the information available. For example, ninety-six crystal structures of hydrates have been established, and it has therefore become possible to devise a classification of hydrate structures based on the clustering of the water molecules into island-like, fibre-like, leaf-like or cage-like arrangements. To cover these categories the words neso-, ino-, phyllo-, and tecto-hydrates have been adopted from the earlier classification of the silicates. This classification brings out the variation in the way the water is included in the structure—a variation extending from practically free water, through hydroxyl and/or hydrogen bonds, to the oxonium ion.

The dielectric constant and dielectric absorption as functions of frequency and temperature have been extensively studied, though it must be said that the results do not lead to any fundamentally new information. Relaxation time and energy of activation can often be determined; but the dynamics of the water molecule in crystalline hydrates are still beyond adequate mathematical treatment.

Numerous infra-red spectra, both of powders and of single crystals, in polarized infra-red radiation have been studied. Bands of absorption or selective reflexion can be identified in many hydrates with the type of binding of the water molecule present. The influence of the surrounding ions can be traced in the changes in frequency and band-width. Like the studies on dielectric properties, the infra-red properties are often of considerable industrial importance, in determining the amount and kind of binding of the water present.

Lastly, enough information has become available to make possible some correlation of the crystal structure of hydrates with their coefficients of thermal expansion, dielectricity, piezoelectricity, elasticity and hardness.

It is intended to publish the papers presented to this conference in a forthcoming number of the *Journal de Chimie Physique*.

The following is a list of the authors and the titles of their contributions:

X-rays and physical properties. J. D. Bernal (London), "The role of water in crystalline substances"; P. G. Owston (London), "The position of the hydrogen atoms in ice"; W. A. Wooster (Cambridge), "The influence of molecules of water on the physical properties of crystalline hydrates".

Dielectric constants. R. Freymann (Rennes), "Absorption of free and bound water in Hertzian spectra"; "Orientation of molecules and lattice defects"; E. Bauer and M. Magat (Paris), "Dispersion of the dielectric constant in crystal hydrates"; J. B. Hasted (London), "Study of water molecules at radio frequencies"; A. Steinemann (Zurich), "Dielectric constant of ice"; J. Chapelle and A. Galy (Nancy), "Dielectric constants of some crystal hydrates"; P. Abadie, R. Charbonniere, A. Gidel, P. Girard and A. Guilbot (Paris), "Study by absorption spectra at radio frequencies of water in the crystallization of maltose and glucose and study of the states of water of sorption in 'amidon'".

Infra-red spectroscopy. J. Lecomte (Paris), "The study of water in solids by infra-red spectra"; R. Mecke (Freiburg-im-Breisgau), "Detection of OH in crystals by infra-red spectroscopy"; D. E. Bethell and N. Sheppard (Cambridge), "Infra-red spectra of nitric acid monohydrate"; A. M. Vergnoux (Montpellier), "Infra-red studies of the OH bands in crystals".

Raman spectra. J-P. Mathieu (Paris), "The Raman effect in hydrated crystals"; L. Couture-Mathieu (Paris), "The Raman effect in gypsum"; R. Lafont and Ch. Bouhet (Montpellier), "The water-bands in single crystals of magnesium and zinc sulphate heptahydrates"; C. Vassas-Dubuisson (Paris), "The Raman effect in a single crystal of lithium sulphate monohydrate"; J. Chapelle and A. Galy (Nancy), "Attempt at orientation of the molecules of water in hydrated crystals by means of the Raman effect"; J. Chapelle, G. Champier and C. Delain (Nancy), "Interpretation of the Raman spectra due to water molecules in Rochelle Salt".

Nuclear magnetic resonance. G. E. Pake (Washington University, Miss.), "Application of nuclear magnetic resonance to the study of the structures of

crystals containing molecules of water"; M. Soutif and Y. Ayant (Grenoble), "Study of the water molecule in lithium sulphate monohydrate"; N. J. Poulis and G. E. G. Hardeman (Leyden), "Position of protons in $CuCl_2.2H_2O$ determined by the method of nuclear magnetic resonance"; W. Gordy (U.S.A.), "The spectra of water vapour in the millimetric range".

W. A. WOOSTER

INTERNATIONAL ELECTRO-ACOUSTICS CONGRESS

AN "International Electro-acoustics Congress" was held in Holland during June 16–24. The congress, which was organized by a Dutch Committee, presided over by Prof. C. W. Kosten, was the first venture sponsored by the newly formed International Committee of Acoustics (I.C.A.), an offshoot of Unesco. It was held in the main at the Technische Hoogeschool, Delft, and was attended by more than three hundred people, representing many countries.

After addresses by the president of the Congress, H. E. the Minister of Education and Prof. R. H. Bolt, president of the International Committee of Acoustics, the Congress settled down to hear general reviews of progress in the seven sections into which the subject had been divided. These are summarized below.

Section I: Sound Recording. R. Vermeulen described improvements which have been made in disk and tape recording. He pointed out the need for defining standards in reproduction apparatus. Frequency response is not the only criterion; the psychological attitude of the hearer and the auditorium in which he listens play a large part in appreciation. Advances in stereophony were pointed out and—later in the Philips works—a two-channel demonstration was given to show that the illusion of space in such a system is still imperfect.

Section II. Public Address Systems. Erwin Meyer pointed out that the loud-speaker remains the weakest link in this type of transduction, which has become so important in modern life. Usually it is more important, at least in speech, to get the high frequency amplified than the bass. Different types of microphones and arrays of loud-speakers were described, and the advantages of delay pick-ups as used in St. Paul's, London, for large auditoria was explained.

Section III: Measurements. L. Beranek emphasized the need for measuring devices which include the listener as part of the system. This science of psycho-acoustics is still in its infancy; but many acoustic measurements are valueless without it. On the purely physical side, the most important developments are in high-frequency microphones for use in a wide range of conditions, in the measurement of acoustic and mechanical impedance.

Section IV: Audiometers. P. Chavasse also pointed out the need for listener research in this field, which should cover not only psychological reaction but also measurements of a more physical character like the impedance of the external ear, diffraction of sound by the head, artificial ears, and establishment of a norm of hearing for all countries.

Section V: Ultrasonics. G. Bradfield described recent advances in transducer design for this range, now going up to 3,000 Mc./s., particularly those involving barium titanate and the ferrites. Transducers for pulse excitation using Rochelle salt or long nickel tubes with the distant end immersed in grease have also been used in delay lines, while for ultrasonic cutting tools, 'Permendur' is used. The characteristics of many of these were discussed through their equivalent circuits or Argand diagrams. More study is needed of the launching of waves in solids, where the energy tends to be transferred to and from transverse and longitudinal waves, complicating the process.

Section VI: Musical Acoustics. E. G. Richardson described the benefits which this branch has derived from advances in electrical tone synthesis. Recent research has shown the importance of a knowledge of the formants (varying timbre over the scale) and transients of musical instruments in differentiating them and assessing their relative excellence. Work on the violin and the organ-pipe in particular was described.

Section VII: Lightweight Structures. C. W. Kosten pointed out the difficulties in building an insulating wall between two rooms without excessive weight. Flexural stiffness and resistance must be introduced to compensate for the light weight, and resonances must be distributed over the gamut. Both cavity walls and filled double-wall structures are employed.

After this the Congress divided into Sections, in each of which ten to a dozen papers were read, that of Section VI being enlivened by demonstrations on various musical instruments varying from bagpipes to just-tempered organs.

On two days visits to Hilversum Radio and Philips Industries, Eindhoven, were made.

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

PARIS MEETING

THE fourth meeting (second annual meeting) of the European Association of Exploration Geophysicists was held in Paris during May 20–22, when about a hundred and fifty members were present, the president, A. van Weelden, being in the chair. Membership now stands at more than five hundred and fifty, a remarkable achievement since the Association's inauguration in December 1951. Affiliation with the Society of Exploration Geophysicists (U.S.A.) has recently been approved, and a paper entitled "The Significance of Diffraction in the Investigation of Faults"[1] by T. Krey, presented at the Association's meeting in London in May 1952 and published in the *Journal* of the Society of Exploration Geophysicists (before the Association's own journal, *Geophysical Prospecting*, was in being), has received the Society's award for the best paper during 1952.

In his presidential address, A. van Weelden discussed the various ways in which the results of gravity surveys are analysed, and emphasized the imperfections and ambiguities in the interpretations which are brought about by unjustified assumptions. In this regard, he stressed the necessity for close co-operation between geologist and geophysicist, a necessity which is sometimes not given full support.

Of the twenty-two papers presented at the meeting, seven were on seismic, six on electrical, four on magnetic, two on gravity and three on general problems in exploration geophysics.

The interpretation of reflexion records obtained over fault zones is receiving much attention by workers in oil-field exploration, as oil may be found in stratigraphic traps up against the fault face, and in a paper by K. H. Seelis (Germany) the diagnostic features such as character of reflexion, abnormal dips, displacement of the reflected arrival and a variation of the velocity/depth distribution in crossing a fault were exemplified by records and depth sections. The last feature was also discussed in a paper by H. A. Rühmkorf (Germany), who noted that the travel times from a well geophone to two surface geophones equidistant, but in opposite directions, from the well differed by a small amount (0·01–0·02 sec.). It was pointed out in the subsequent discussion, however, that care must be taken to eliminate any time differences due to an uneven thickness of the very low velocity (2,000 ft./sec.) near-surface beds.

In computing depths to the reflecting bed, the normal procedure is to employ an average velocity; but this only holds for small dips. When the geological layers are much inclined, some allowance must be made for varying layer velocities, and H. Dürbaum (Germany) presented formulæ for the direct determination of them from the records; he also discussed the errors introduced by assuming average velocities in such cases. An interesting account of reflexion investigations in the Swabian Molasse basin in front of the Bavarian Alps was given by W. Elberkirch (Germany). Here the erratic glacial drift is largely responsible for the paucity of the reflexions; but the top of the Mesozoics appears to offer a useful key horizon, the deepest part of the Tertiary basin holding an estimated 10,000 ft. of sediments.

H. Menzel (Germany) described laboratory studies of the propagation of elastic waves in a solid with elastic afterworking. He found that high-frequency waves are not absorbed as is the case in visco-elastic theory, and considered that some modification of the latter theory in accounting for the shapes of seismic onsets is desirable.

All seismic workers are familiar with graphical methods of constructing depth-sections, but the conversion of a time-section when the velocity is not constant leads to refraction complications across the various seismic layers. To obviate lengthy computations, however, J. Dienesch and H. Richard (France) have evolved and presented geometric constructions in reflexion problems of this kind.

A most informative paper on explosives in seismic prospecting by S. H. Davidson, R. Westwater and J. Hancock (Great Britain) brought the seismic session to a close. Chemical stability, freedom from grit contamination and transportation and preparation of the explosive for lowering into the shot-hole were all discussed. In order to lessen the hazards in operation, a new explosive, 'Seismex', with an ammonium nitrate base, has been produced in recent years by Imperial Chemical Industries, Ltd., but owing to its hygroscopic nature it is cased in water-tight tins; it suffers the disadvantage, however, of not being able to stand up to the great pressures sustained by the nitroglycerine explosive, 'Geophex', which is capable of exploding under a water pressure of 1,000 lb. per sq. in. In the following discussion, some interesting observations were made on sympathetic explosions of a second buried charge situated a short distance from, and on firing, the first; methods for distinguishing between the sweating of nitroglycerine and the presence of water particles on the explosive surface in tropical climates were also described.

Geophysics is playing an increasing part in the coal mining industry, and the National Coal Board of Great Britain has a wide programme of research on problems affecting the safety of the mine and mine-worker from subsidence of unconsolidated strata and a waterlogged overburden. In a paper by G. M. Habberjam and J. T. Whetton, an account was given of a resistivity investigation into an old river valley in Coal Measure strata, the trend of the valley being completely delineated. A second paper by E. Jan Polak described the attempt to demarcate the freshwater Trias formations from the brackish Coal Measures; but lack of homogeneity in electrical properties of the rocks resulted in a rather indefinite boundary. The exploration for water by (*a*) electrical and (*b*) seismic refraction methods in the desert areas of Mauritania (Morocco) was discussed in an interesting paper by J. J. Breusse and G. Huot (France). Close agreement between the thicknesses of the clay–sandstone complex resting on a crystalline basement was found by the two methods, while it was also found possible to distinguish between fresh and saline water areas. Six drill holes put down afterwards corroborated the general results of the surveys.

The important branch of electrical surveying which has to do with measurements in bore holes was represented by three papers. The first, by A. P. Poirault (France), reviewed the development of gamma-ray logging, micro-logging and side-wall sampling as applied to holes drilled for minerals other than oil, and described the results obtained in the case of coal seams in England, lignite deposits in the Cologne basin and the potash beds in Alsace. A second paper, by I. Wendt (Germany), discussed a method using two counting tubes for determining the radioactive potassium in thin deposits, while a third paper, by L. Solaini (Italy), gave an account of an instrument for measuring resistivity with alternating current at 20 c./s.

In the magnetic section a paper by S. Matweber and K. Jung (Germany) described how a reasonable interpretation of a very detailed vertical intensity survey (station interval 30 ft.) in the Red Iron district of Lahn and Dill attributed some small-size anomalies of large magnitude to a variable magnetic content of underlying diabase. On drilling, however, iron ores rich in magnetite were penetrated at shallow depth before basement was reached. In discussion, it was agreed that measurements of the vertical gradient of intensity by means of observations on elevated platforms would lead to a nearer estimate of the depth to the magnetic disturbance. F. Sumi (Yugoslavia) introduced a somewhat academic note when he discussed the magnetic anomalies to be expected from spheres and cylinders, and A. Lundbak (Denmark) reviewed the limiting factors in airborne magnetic surveys and referred to some recent modifications of the fluxgate magnetometer. Most workers with the vertical magnetometer of the Schmidt type believe that constructional errors are eliminated by taking the mean of magnet readings in azimuths 180 degrees apart; but J. McG. Bruckshaw (Great Britain) demonstrated that, as the inclination of the knife edge is fixed by an arbitrary setting of the levels, elimination of errors due to this inclination and to misorientation is incomplete. Formulæ permitting the determination of the tolerance in knife-edge tilt and azimuth in any particular case were given.

C. Aynard (France) presented a paper on the interpretation of the gravity results obtained in the Gharb basin of Morocco and compared them with the known geology and the results of seismic and electrical surveys; it appeared that most of the local gravity features are related to the pre-Riff tectonics. In precision gravity surveys, corrections are made for diurnal variation, and C. Morelli (Italy) explained that the determination of the diurnal variations for northern Italy now being effected at the Geophysical Observatory, Trieste, can be extended with slight modifications to almost the whole of Europe, the work being facilitated by the use of nomograms. In the following discussion it was agreed that the Council should consider the appointment of a committee to study this important matter.

Papers which compare the results of various surveys in the same area are particularly stimulating, and such was the case when A. M. Selem and C. Monnet (Italy) gave an account of the seismic reflexion, telluric and gravity surveys in the Ferrara area of northern Italy, where an early torsion-balance survey had indicated a broad uplift in the Tertiary and Mesozoic formations. A broad agreement was shown to exist among the results given by the three methods. A further comparison was made by means of the derived vertical gravity-gradient (using Baranov's formula presented at the previous meeting of the Association in Hanover) in the area where reflexions were poor; agreement with the telluric results was marked. Geological data from two wells drilled to 1,300 ft. and nearly 2,100 ft. over the uplift tended to support the geophysical conclusions.

The degree of certainty of the interpretation of geophysical results was discussed in a paper by M. Matschinski (France). Here the problem was divided into four parts: (*a*) mathematical description of a hypothetical geological structure satisfying the geophysical data; (*b*) determination of the parameters defining the structure; (*c*) the likelihood that these parameters are the only ones; and (*d*) determination of the likelihood of the hypothesis itself. The necessity for accepting some limitation for parameter variation was discussed, and applications of the general theory to seismic and gravity measurements were given.

The technical session closed with a paper dealing with safety regulations in geophysical prospecting by H. Richard (France) and the showing of a 'Technicolor' film entitled "Make no Mistake" (presented by courtesy of Geophysical Service Incorporated, U.S.A.). These provoked considerable discussion, and it was agreed that a special committee be formed to consider and make recommendations on this very important subject.

It is to be regretted that spoken language difficulties were emphasized by the almost complete lack of copies of the various papers. Abstracts were not available to members until just before the meeting, so that even if the speaker's language was understood, there was little or no time for a member to consider carefully the points brought out in a paper with the view of joining in the discussion. It is to be hoped that copies of the papers for the next meeting, probably in Italy, will be circulated well in advance, so that it would only be necessary for the speaker to dwell on the salient or controversial parts of his subject in a relatively short time, thus leaving a much desired longer time for the discussion.

Some very informative exchanges of experiences and ideas were made between members outside the lecture theatre, and this more personal contact is obviously a most attractive feature of the meetings. The Compagnie Générale de Géophysique and the Société de Prospection Electrique kindly made all the arrangements for the meeting, which included several enjoyable sight-seeing tours for members' wives.

The following officers were elected for 1953–54: *President*, D. T. Germain-Jones (Great Britain); *Past President*, A. van Weelden (Holland); *Vice-President*, J. Goguel (France); *Secretary/Treasurer*, B. Baars (Holland); *Members of Council*, A. Schleusener and F. Werner (Germany), J. L. Mathieu (France), T. Rocco (Italy), J. McG. Bruckshaw (Great Britain) and D. Malinqvist (Sweden).

T. C. RICHARDS

[1] *Geophysics*, **17**, No. 4 (Oct. 1952).

LIBRARY FACILITIES IN THE UNITED STATES

AMONG the papers presented to the Library Association at its annual conference at Llandudno during April 28–May 1, that of Mr. R. W. L. Collison on aspects of co-operation in university and special libraries in the United States of America appears to be the one of most interest to scientific workers or technologists as such. Mr. Collison began by referring to the awareness of librarians in post-war America of the need for the closest co-operation between all types of libraries, particularly between those libraries which are in any way concerned with the advancement of research and scholarship, and to the extent to which practical co-operation between university and special libraries has already developed in the United States. Even many American librarians, however, are unaware of the full implications or of the general pattern. Much has been achieved, for example, by the wide exchange of catalogue entries between university and special libraries interested in the same subject or group of subjects. From this it is but a short step to the co-operative planning of book purchase, such as the long-standing agreement between the John Crerar Library, the Chicago Public Library and the Newberry Library as to which subject-fields each will cover. Book- and serial-withdrawal has become a fruitful field for extensive co-operation, and the establishment of the Mid-West Inter-Library Centre in which, besides university libraries, the Illinois Institute of Technology and the John Crerar Library are co-operating, has led to substantial economies as well as to the filling of important lacunæ.

There is no inter-loan system as comprehensive as that established in Great Britain, continued Mr. Collison; but some bibliographical centres have developed their services further than any single regional bureau in Britain. Almost every field of research in the area has availed itself of the services of the Philadelphia Centre, and important industrial libraries are co-operating. The scale of assistance of university libraries to special libraries in the United States is unequalled in any other country, and the universities in the United States usually pay much attention to local industries and professions. Organizations on both sides are very willing to exchange publications, while the universities often undertake important schemes of research on behalf of Federal,

State, or private bodies in return for considerable grants of money to cover the costs involved, thus often strengthening the holdings of the university library in subjects where it was weak. Mr. Collison went so far as to suggest that this strong link between commerce, industry and the university helps informally to direct research material to the most appropriate library. He also pointed out that in the United States the membership of most university libraries is almost unrestricted, provided a serious purpose is proved, and special libraries have little hesitation in approaching university libraries for help and for the loan of books, reciprocating by admitting readers recommended by the universities.

On the national scale the wise guidance of the Library of Congress can be seen in all aspects. The work of this Library in co-ordinating the efforts of all types of libraries is invaluable : its bibliographical aids were evident in every research library, and in return it does not hesitate to call on libraries with specialist knowledge to assist in the preparation of catalogue cards, bibliographies, etc., of specialist material. Besides the Farmington Plan, which has been revised so that the coverage of subjects is reduced to a much smaller number of libraries, while government publications are now included, there is the war-time scheme of the Library of Congress for obtaining for research libraries books and periodicals published in enemy countries and a similar scheme for Russian material. The National Union Catalogue contains entries for about fifteen million items in research libraries of all types, and inter-library book exchange is helped by extraordinarily low postage-rates. An important development has been the establishment of the Association of Research Libraries, comprising some forty leading libraries in the United States, and the considerable amount of informal co-operation between university and special libraries can be extended formally and informally without major alterations in the policy of either type of library. There is now contemplated the transfer to a regional library created for the purpose of extra-local responsibilities which local research libraries more and more find themselves bearing.

EXCAVATIONS AT MARGIDUNUM

In his latest report[1], Dr. Felix Oswald continues the story of his work at Margidunum with an account of the area in the southern half of the site extending from the *Via Quintana* to the Counterscarp. This includes the site of the southern rampart with various pits and wells, and the first four outer ditches, as well as the smaller outer ditches V and VI which outline a paved patrol path for sentries placed along the Counterscarp. The Insula containing the Commandant's House, described in an earlier account in this series[2], lies immediately to the north of these features, on the other side of the *Via Quintana*.

The present report is chiefly concerned with the pottery and other objects found, the material being illustrated by a series of plates, each accompanied by a description of the individual items. The rest of the text is devoted to further description and discussion ; but unfortunately this is marred by several unlucky misprints, for example, on p. 6, Plate IX in the second paragraph should read Plate VII, and XIII on p. 8 should always be replaced by a XII. The earliest finds, those dating from the mid-first century A.D., come from ditch 5 beside the *Via Quintana*, and ditches 9, 10 and *Z*. As well as some unusual Terra Sigillata, they include interesting examples of butt beakers, rusticated and green glazed wares, and storage jars. Of slightly later date is a grey urn with a pronounced cordon below the neck with four *appliqué* hares seated upon it, an attractive discovery found in the lower levels of one of the stone-lined wells. Iron ore and slag came from some of the pits in the area demarcated by ditch 10, and these were obviously used for smelting ; they were straight-sided and resemble pits used for similar purposes in parts of Africa. Another pit, near the junction of ditches 9 and 10 this time, contained the skeletons of six large dogs, probably injured in wild boar hunts in the nearby forest.

Towards the end of the first century, ditch 10 seems to have been used as a foundation trench for one wall of a building, identified as a stable after the excavation of pits in this area containing horse dung (still fresh), yellow straw, twigs and other stable litter, preserved from decomposition by a sealing layer of clay. The later history of the site is represented by some second-century pottery from the outer ditches, and the contents of the third century well already described in an earlier publication[3]. Pottery of the third and fourth centuries was also found in outer ditch III, while outer ditch I was partly obliterated by a late fourth-century wall.

Joan Liversidge

[1] Excavation of a Traverse of Margidunum. By Dr. Felix Oswald. Pp. 47+19 plates. (University of Nottingham, 1952.) 7*s.* 6*d.*
[2] Oswald, F., "The Commandant's House at Margidunum" (1948).
[3] *J. Roman Studies*, **16**, 36 (1926).

AEROPLANE OBSERVATIONS OF HOMING PIGEONS

The homing of domestic pigeons and the migrations of wild birds are often considered as comparable cases of natural navigation. In both types of long-distance flight it is difficult to discover adequate guiding cues that lie within the sensitivity range of the birds' sense organs.

Direct observation from aeroplanes has recently thrown some light on the actual routes which wild birds use in finding their way home to their nests after being artificially transported to a distance. Herring gulls and gannets were observed to make exploratory flights in many directions, flights which covered a wide area surrounding the release point and which probably brought the birds, in time, within sight of familiar landmarks. It therefore seemed desirable to apply to pigeons the same technique of aeroplane observation which had been developed for use with wild birds, and this has been done by Donald Griffin (*Bull. Mus. Comp. Zool.*, **107**, No. 8 ; December 1952).

Fifteen observation flights over distances up to a hundred miles disclosed several cases in which the birds appeared to be relying upon exploration or topographic landmarks. In other instances there was a definite tendency for the pigeons to head in the approximate direction of home, even when flying over what was almost certainly unfamiliar territory. Despite the fact that no final conclusions can be drawn from the results of these observations, the homing behaviour of these pigeons is of interest in view of the scarcity of precise, adequately controlled

descriptions of the actual routes between release points and home loft.

From this investigation and those of other workers, Griffin concludes that it is advisable to distinguish three distinct levels of navigational ability. What may conveniently be called type I homing is reliance upon "contact flying" within familiar territory. When released in totally unfamiliar territory, birds which exhibit only type I homing show a quantitative homing performance that can easily be accounted for by theories of exploration or even by a completely random search for familiar landmarks. They may be misled by topographic features resembling portions of their familiar territory.

A second level of homing, conveniently designated type II, is the ability to maintain flight in roughly a fixed direction, usually that adhered to in previous training flights.

There is also a third level of homing ability, conveniently designated as type III, which permits birds to fly approximately straight towards home from unknown territory regardless of the direction in which home lies.

While differentiating between these three types, the same flock of pigeons may exhibit two, or even all three, of these types of orientation at different times during a single homing flight.

Finally, it must be admitted that the central problem of pigeon navigation remains unsolved; the sensory basis of orientation in both type II and type III homing is still a matter for speculation. The results achieved to date point towards a sort of celestial navigation based upon the sun and sky brightness patterns.

VARIATION OF HUMIDITY WITH HEIGHT IN THE LOWER ATMOSPHERE

DURING the Second World War, a need arose for detailed information on the variation of humidity with height in the lower layers of the atmosphere in connexion with research into the refraction of the electromagnetic waves used in radar and high-frequency radio communication. The temperature structure in the vertical and its variations were known in considerable detail from work at Porton and Leafield, by Sir Nelson Johnson and Mr. G. S. P. Heywood, published in Geophysical Memoirs 46 and 77, but no such information existed for humidity. To remedy the deficiency the Meteorological Office set up apparatus near Rye, Sussex, recording temperature and humidity at 1·1 m. and on an open-lattice mast at heights of 15·2, 47·2 and 106·7 m. Temperature was recorded continuously by resistance thermometers and relative humidity by Gregory humidiometers enclosed in aspirated screens.

Geophysical Memoir 89* describes the apparatus in detail and summarizes and discusses the observations made at Rye during July 1945–June 1948. The temperature observations at Rye differed little in their main properties from those made by Johnson and Heywood, and in this note attention will be concentrated on the humidity. Humidity is expressed in the Memoir in milligrams of water vapour per cubic metre; mean values of this quantity at 1·1 m. are about 11,000 in midsummer and 5,000 in midwinter.

The variation of humidity with height is similar to the variation of temperature with height. There is generally a decrease (lapse) with height in the middle of the day and an increase (inversion) at night. The largest variations occur near the ground. The vertical gradient decreases with height.

The diurnal variations are of great interest, especially on clear days in summer when, as would be expected, they are most pronounced. Humidity near the ground on clear days increases quickly after sunrise as insolation evaporates water from the ground surface, and there is a sharp maximum two to three hours later. A lapse of humidity forms and quickly becomes of the order of 1,000–1,500 mgm./m.³ between 1·1 m. and 106·7 m. Increasing turbulence then transports water vapour upward more quickly than it is evaporated so that humidity near the ground and the lapse-rate decrease again. In the evening turbulence decreases, so humidity near the ground increases again, until after sunset the lapse of humidity changes over to an inversion and water vapour diffuses down to condense on the ground. There is a minimum of humidity and the most pronounced inversion at dawn; an increase of some 800 mgm./m.³ between 1·1 m. and 106·7 m. is then observed. After sunrise the inversion breaks down very quickly as evaporation begins.

The Memoir concludes with a description of the temperature and humidity gradients observed in radiation fog. The general picture is of an inversion of both temperature and humidity in the lowest layers in the early stages of fog. These inversions weaken in low layers as the air cools further and the depth of fog increases but extend upwards to continually increasing heights. Relative humidity inside the fog remains almost constant but need by no means reach 100 per cent.

The Memoir reports an investigation of fundamental importance in meteorology and will undoubtedly be consulted as much as its similar predecessors, Nos. 46 and 77.

* Temperature and Humidity Gradients in the First 100 m. over South-East England. By A. C. Best, E. Knighting, R. H. Pedlow and K. Stormonth. (Air Ministry: Meteorological Office, Geophysical Memoirs No. 89, M.O. 530d.) Pp. 60. (London: H.M. Stationery Office, 1952.) 7s. 6d. net.

HISTOCHEMISTRY OF XANTHINE OXIDASE

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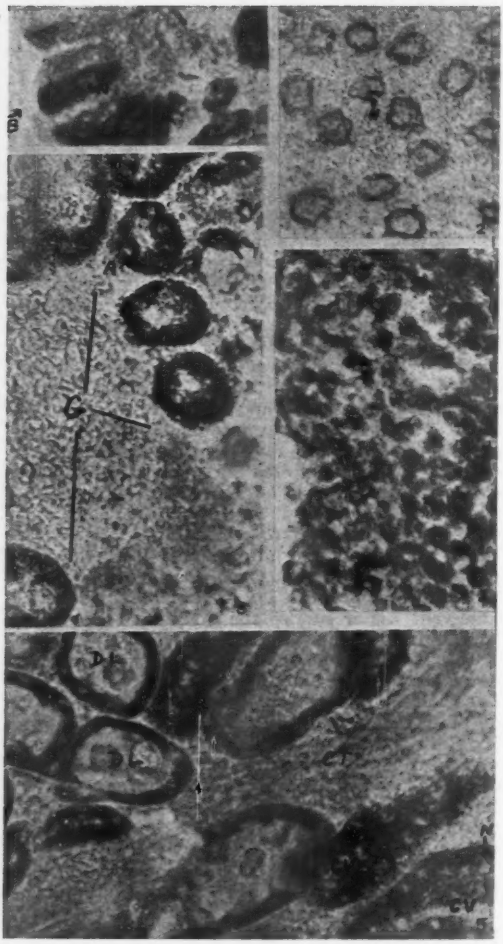
IT was shown by Shelton and Schneider[1] that a mixture composed of purified xanthine oxidase, hypoxanthine and phosphate buffer at a *p*H of 7·5, when incubated with neotetrazolium, reduced the latter to an insoluble coloured diformazan. The reaction was similar to that produced by succinic dehydrogenase in the presence of succinate. Since the latter enzyme has been demonstrated histochemically by this method (Seligman and Rutenberg[2]), it was decided to attempt the histochemical localization of xanthine oxidase in a similar way.

A substrate mixture containing 3×10^{-4} *M* xanthine in 0·075 *M* sodium pyrophosphate buffer, giving a *p*H of about 8·2, was used and to this was added 50 mgm. of neotetrazolium chloride. Nitrogen was bubbled through this mixture for 20 min., and it



(1) Xanthine oxidase reaction in jejunal epithelial cells. Note negative nucleus (*N*) and negative brush border and distal portion of cell (*B*). × 360

(2) Portion of inner part of cortex of kidney to show positive xanthine oxidase reaction in descending limbs of Henle's loops. Negative nuclei (*N*) may be seen. × 195

(3) Glomerulus (*G*) containing some xanthine oxidase-positive granules, surrounded by proximal convoluted tubules containing many positive granules. Negative reaction by the nuclei is particularly obvious in one of the tubes (*A*). × 330

(4) Granular xanthine oxidase reaction in the liver cells. Nuclei are negative but this is obscured by the large number of granules in the cytoplasm. × 240

(5) Inner part of cortex of kidney. Note positive xanthine oxidase reaction by descending limbs of loops of Henle (*DL*) and by convoluted tubules (*CV*). Negative reaction by nuclei in both types of tubule is apparent. Collecting tubules (*CT*) only slightly positive. × 600

was divided between two glass-stoppered tubes each of which was filled to the top so that when the stopper was replaced all air was excluded. In one of these tubes sections, 50 μ thick, of fresh frozen tissue were placed; in another, slices of tissue about 2 mm. thick. (Best results were given by the latter.) The tissues used were liver, kidney, spleen and small intestine, these having been shown by Westerfeld and Rickert[3] to have the highest xanthine oxidase activity. When whole pieces of intestine were used, they were opened up so that the epithelial cells were in direct contact with the substrate.

The reduction of the tetrazolium began even in the cold, and in a few minutes the tissues had a pale pink colour due to the formation of diformazan. Incubation was carried out for 1 hr. Following this, the sections and the pieces of tissue were washed in distilled water and placed in 10 per cent formaldehyde for 3 hr. The frozen sections were then washed and mounted in Apathy's medium. The pieces of tissue were washed and embedded in 'Carbowax' and sections 8 μ thick were cut and, after removal of wax, mounted in glycerine jelly.

Two types of reaction were observed in the cells. First, a dark red diffuse reaction (which according to Seligman and Rutenberg[2] is given in the succinic dehydrogenase reaction by regions of low activity) and a deep blue granular reaction which, according to the same authors, is given by regions of high activity. All cells which gave a positive reaction showed it in this dual form. The granular reaction appeared to be in formed elements of the cell which appeared similar in form to mitochondria. It is possible that the low activity in other parts of the cytoplasm may have been due to diffusion of the enzyme during incubation from these sites of high activity. It was noteworthy, however, that the nucleus in all cells appeared to be completely negative, and to be not even a region of low enzyme activity; thus the xanthine oxidase reaction is entirely cytoplasmic in distribution. One cannot, of course, be certain that the nucleus is devoid of activity even so, since the nuclear membrane may be impervious to the passage of the substrate and/or the tetrazolium; nevertheless, this negative reaction is striking. Another negative area is shown by the brush borders of the epithelial cells of the small intestine. Not only is the brush border entirely devoid of any reaction, but a small band of cytoplasm immediately beneath it is also negative. The greatest reaction seems to be between this region and the nucleus, although the basal part of the cell is also very active. It is significant that there should be completely negative portions of the cytoplasm which are indeed sharply delineated from the positive areas. This fact suggests that the non-granular low-activity reaction is not due to diffusion from centres of high activity.

A granular reaction was also given by the bases of the crypts of Lieberkuhn. The smooth muscle gave a slight reaction (granular), and the connective tissue between the muscle layers was more active than the muscle.

In the spleen certain cells in the red pulp, the identity of which could not be established, gave a greater reaction than any other parts of the organ.

In the liver the peripheral cells of the lobules appeared more active than the more centrally placed cells, a fact which is in keeping with other evidence (see, for example, Malaty and Bourne[4]) that the outer cells are metabolically more active. The granular reaction in the liver cells is not as uniform as it is in the cells of other tissues. There seem in addition to the round granules to be many short and elongated rod-shaped positive objects, and it is difficult to be certain that these represent formed elements of the cells. Some of them look more like crystals of diformazan. However, if they are the latter, it is curious that they should be present only in liver and not in other tissues incubated with them in the same substrate in the same tube.

In the kidney the reaction is similar to that for succinic dehydrogenase in being most intense in the proximal convoluted tubules and the descending

limbs of Henle's loops. In the latter it is more diffuse than granular. The glomeruli are largely negative, though there are a few positive granules in the cells. The ascending limbs of Henle's loops and the distal convoluted tubules also give a reaction. The collecting tubules give a mixed reaction and some of them appear positive even in the medullary part of the kidney.

It is desirable that further work be carried out on this reaction before proper assessment of the significance of the results can be made; but the two facts of great interest which have emerged from it are the negative reactions given by the nuclei of all the tissues examined and by the brush borders.

I am greatly indebted to Prof. F. Bergel and Mr. R. C. Bray, of the Chester Beatty Research Institute, for a supply of buffered substrate and for helpful suggestions; to Dr. H. A. Malaty for cutting some of the frozen sections; and to Mr. J. Linder for cutting 'Carbowax' sections of some of the preparations. The neotetrazolium used was in part a gift from Dr. W. C. Schneider, of the National Institutes of Health, Bethesda, U.S.A., and in part purchased with the aid of a grant from the Medical Research Funds Committee of the London Hospital.

[April 4.

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[3] Westerfeld, W., and Rickert, D. A., *Proc. Soc. Exp. Biol.*, **71**, 181 (1949).
[4] Malaty, H. A., and Bourne, G. H., *Nature*, **171**, 295 (1953).

HUMAN VISUAL PURPLE

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BIOCHEMICAL studies of the visual pigments have been restricted almost entirely to animals lower than man. The frog's retina has proved a convenient source of material and much precise information exists on frog visual purple. In contrast, knowledge of the corresponding human pigment is meagre although a wealth of data on human vision has been collected. This situation has led to the use of the frog data in the interpretation of certain human visual functions. The assumption that the scotopic pigments of the two organisms are identical is based on the resemblance between the absorption spectrum of frog visual purple and the human scotopic sensitivity curve.

Recently, through the co-operation of the surgeons and staff of the Moorfields, Westminster and Central Eye Hospital (Moorfields Branch), we have obtained some human material for examination. The purpose of this article is to present evidence that human visual purple is spectrophotometrically different from frog visual purple and to apply the new data to some old problems.

The present information was obtained from a dark-adapted eye removed because of the presence of a ciliary body melanoma. The patient, a man aged fifty-three, readily consented to wear a light-proof mask over both eyes for three hours. The operation (removal of right eye) was then carried out in deep red light in an otherwise completely dark operating theatre. The eye was placed in Ringer–Locke's solution in a lightproof container and brought to the laboratory. Here, again in deep red light, the retina was obtained by the following procedure. After first removing the cornea and lens which were required for other purposes, the eye was divided into two portions by cutting around at the level of the ora serrata. The anterior portion containing the melanoma was then passed to the Department of Pathology for routine examination. The posterior portion was gently squeezed to extrude the vitreous. With a soft paint-brush the retina was then eased away from the underlying choroid. The retinal mass was picked up with forceps and, after severing its connexion with the optic nerve, was placed in 35 per cent sucrose solution.

Vigorous shaking then caused the outer limbs of the retinal end organs to break off[1] and become suspended in the sucrose solution[2]. On centrifuging, the retinal debris was precipitated; but the outer limbs remained suspended in the supernatant. This was pipetted off. A second suspension of outer limbs was obtained by adding further sucrose solution to the residue and repeating the whole procedure. The two suspensions were diluted to reduce the specific gravity, and on centrifuging them the outer limbs were precipitated. These were washed and bulked and then treated with two successive 0·5-ml. portions of freshly prepared 2 per cent digitonin solution to extract the visual pigment. The combined extracts were made alkaline by the addition of 0·1 ml. of saturated sodium borate solution.

Portions of this solution were examined spectrophotometrically using apparatus and technique previously described[3]. The absorption spectra before and after exposure to white light are shown in Fig. 1*A* by the curves marked 'unbleached' and 'bleached', respectively. In general form these curves are typical of results obtained with extracts from the retinæ of other vertebrates. Both before and after exposure to light the solution was thermally stable, as is shown by the correspondence between the measurements made going up the wave-length scale (open circles) with those going down (filled circles). No subsequent regeneration was observed; even after 17 hr. in darkness at 20° C., the absorption spectrum of the bleached solution remained unchanged.

The extract was, of course, a crude preparation containing impurities. Consequently the 'unbleached' curve of Fig. 1*A* is only a rough approximation to the true absorption spectrum of the visual pigment. The left-hand limb of the curve is most affected since the impurities absorb with increasing strength as the short wave-length extreme of the visible spectrum is approached.

For analytical purposes it is often useful to plot the change in density at each wave-length which occurs on bleaching. Such difference spectra eliminate the effects of stable impurities and express simply the difference in spectral properties between the photosensitive pigments and their photoproducts. Provided the *p*H is controlled (necessary because the absorption spectra of the photoproducts are dependent on *p*H), difference spectra are accurately reproducible and afford a means of comparing results from different species with a high degree of precision[3].

The difference spectrum derived from the 'unbleached' and 'bleached' curves of Fig. 1*A* is plotted as open circles in Fig. 1*B*. This figure also includes

* On sabbatical leave from the University of California, Los Angeles, aided by the University of California Board of Research.

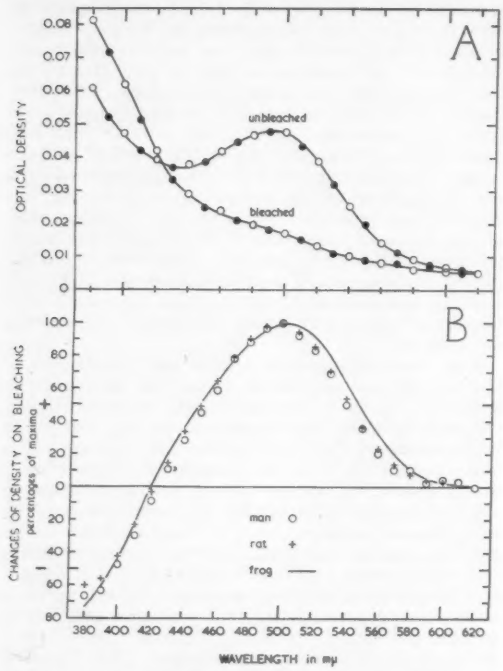

Fig. 1. *A*, absorption spectra of the human extract before and after exposure to white light. ○, readings taken from 380 to 620 mμ; ●, return readings from 610 to 390 mμ. *B*, comparison of the difference spectra (max. = 100) for man (*p*H = 8·2), albino rat (*p*H = 8·5) and frog, *Rana esculenta* (*p*H = 8·6). All measurements at 20° C.

results previously obtained in this laboratory for the albino rat (crosses) and the frog (continuous line). The difference spectra for man and rat agree with one another but differ systematically from that for the frog, which has a maximum at a wave-length some 5–6 mμ higher. Since the absorption maximum of frog visual purple is at 502–503 mμ, this indicates the position of the maximum for the human (and rat) pigment to be at 497 mμ within limits of ± 2 mμ. This substance, in accordance with the nomenclature system proposed by one of us[3], may be called visual pigment 497.

The true absorption spectrum of this pigment will not be directly known until pure solutions of it can be prepared. In the meantime, however, the probable curve can be constructed from the visual pigment nomogram[4], a device which depends on the observation that all the broad-band visual pigments known have absorption spectra of similar shape when plotted on a frequency scale. The curve so obtained for visual pigment 497 is shown in Fig. 2 by the continuous line, together with the absorption spectrum of visual pigment 502 (frog visual purple) by the interrupted line.

To ascertain the role of visual pigment 497 in human vision, it is necessary to relate its absorption spectrum to a retinal sensitivity curve. The presence of this pigment in the rat retina, which is almost devoid of cones, suggests it to be a rod pigment and hence relevant to a scotopic function.

Many measurements of the human scotopic sensitivity have been made; the latest and, probably, the best being by Crawford[5], who reviews the earlier work. Crawford's relative sensitivity values (mean of fifty observers) were specified with respect to the energy incident on the cornea. They are shown in Fig. 2 by the symbol ⊕ after re-calculation to refer to the quantum intensities incident on the visual pigment layer of the retina; in the transformation, Ludvigh and McCarthy's values[6] for absorption of light by the pre-retinal media were used. In Fig. 2 the retinal sensitivities are compared with the absorption spectra of visual pigment 497 (man) and visual pigment 502 (frog). Apart from the violet region of the spectrum where variations in individual observers make the allowance for pre-retinal absorption uncertain, the sensitivity data are in excellent agreement with the constructed curve for visual pigment 497 and in distinctly worse agreement with the curve for visual pigment 502. This strongly suggests that visual pigment 497 is the scotopic pigment of human vision and supports the contention of a species difference between the pigments of frog and man.

On theoretical grounds a further factor should be considered when relating a pigment with a visual function. Sensitivity data should be compared with the amounts of light absorbed by the pigment *in situ*[7]. In the present instance the concentration of visual pigment 497 was calculated to be equivalent to an optical density of 0·016 (at 497 mμ) assuming an even distribution over a retinal area of 9 cm.². This figure, in good agreement with the value 0·018 derived[7] from König's results, includes amounts of the pigment found in the retinal washings and in a final extract of the rod-denuded retina as well as in the main extract. An optical density of 0·016 corresponds to an absorption of only 3·5 per cent. For such a small concentration the curve expressing the spectral variation of light absorbed is scarcely distinguishable from the absorption spectrum and there is little point with the present data in refining the comparison.

In another respect, however, this result, if accepted as normal, has a greater practical significance. Hecht, Shlaer and Pirenne[8] found that, for light of wave-length 510 mμ, between 54 and 148 quanta incident on the cornea were sufficient to stimulate vision under

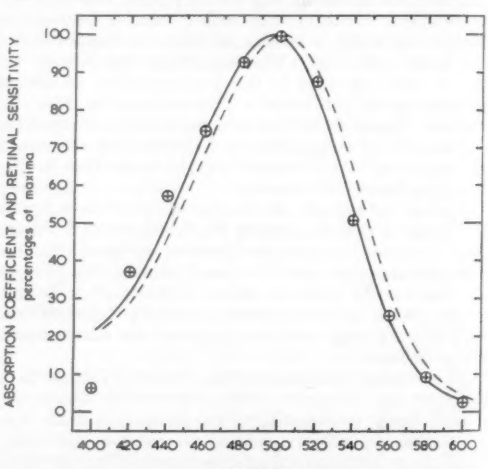

Fig. 2. Comparison of the human retinal scotopic sensitivities (⊕) with the absorption spectra of visual pigment 497 from man (——) and visual pigment 502 from the frog (– – –)

optimal physiological conditions. Allowing 4 per cent loss by reflexion at the cornea, 50 per cent loss by absorption in the pre-retinal media and 20 per cent absorption of the remaining light by the visual pigment, they arrived at 5–14 quanta as the retinal stimulus threshold. Their figure of 20 per cent absorption by the visual pigment was based on an indirect calculation in which it was implied that the scotopic pigments of frog and man were identical. If, in place of this figure, the present one of 3·5 per cent is used, the stimulus threshold becomes 1–3 quanta approximately. This result, if confirmed, may have a considerable bearing on theories of excitation of the retinal rods. [March 16.

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A WIDESPREAD FUNGISTASIS IN SOILS

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RESEARCH in soil mycology at Bangor has been carried on since 1947. Starting with an attempt to discover where, and to what extent, the common mucorine moulds grow and sporulate[1] in relatively undisturbed forest soils, it was soon extended to include other 'sugar fungi'—to use Burges's[2] term for soil fungi unable to attack cellulose or lignin.

Preliminary work, in part by G. D. Holmes (unpublished) in 1948, showed that cellulose film, buried in the soil without protection, is not a satisfactory substrate for studying the growth of such moulds, although when protected between glass slides it supports their growth and some sporing.

From October 1950 the work has been carried on by W. H. Hinson. The use of nutrient in the soil was entirely abandoned, and a variant of the Rossi–Cholodny slide method, suggested by the 'slide-traps' of La Touche[3], was adopted. This consisted of two sterile microscope slides, held together by rubber bands, the slides in contact at one end, but separated by a glass fibre 0·7 mm. thick at the other. These 'gap-traps' were inserted in the faces of soil pits in two forest soils, under spruce and beech respectively, and lifted after fourteen days, at which time numerous mycelia may normally be seen spreading from the edge on the two protected glass surfaces, whereas on the surfaces exposed to the soil hyphæ were seen only sporadically at points where the soil was judged not to have been in contact.

Isolations from these 'gap-traps' gave a range of 'sugar fungi', mainly *Penicillium* spp. and Mucorales, which showed variations of only minor importance with weather, season, soil horizon or site, and in the course of the work it became clear that spores, germinating in condensed water between the slides, provided the origin of many, at least, of the hyphæ seen and the isolations made. Chesters[4] has pointed out the importance of condensation on buried slides in changing the soil environment; but the significance of spore germination in such condensed water in a protected niche within the soil mass does not seem to have been fully realized hitherto. It raises the question: Why have not such spores germinated previously in the soil itself, where water is amply available?

The behaviour of spores in the soil is difficult to observe, though Legge[5], by an ingenious technique using glass-fibre tape, has recovered the relatively large oospores of *Phytophthora* spp., some ungerminated, after as long as a year. We found that spores of *Penicillium frequentans*, placed in a sintered glass pad in contact with soil, after a week showed negligible germination restricted to a few lodged on upper surfaces of the glass on which condensation may have occurred. Spores of *Penicillium nigricans*, chosen for its recognizably spiny conidium, when placed directly in moist soil, could be recovered from the centre of the soil mass, ungerminated, up to one month. Later it was found possible to demonstrate 100 per cent inhibition of germination, by the use of cellulose film in the soil, which was impossible to demonstrate by these preliminary methods; but they at least showed that the inhibition is present in the soil itself and is not generated in some way by the film.

The cellulose film used is the thinnest commercial wrapping material, about 20 μ thick, which is cut into 2-in. squares, boiled to remove the surface dressing, lightly autoclaved, and while still slightly damp, dusted with the test spores, if xerospores, or sprayed with a dense suspension of them and allowed almost to dry in the case of gloiospores. The square is then folded with the spores inside, partially buried in moist soil, and pressed firmly so as to secure intimate contact with the soil surface. With every fresh soil so far tested in this way the germination of the test spores has been completely inhibited on the area of the film with which the soil is closely in contact, and on no other part of it. Germination and growth occur freely on the 'margins', that is, the parts of the film not in contact with the soil, but the hyphæ will not grow into the soil-contact area. No such complete suppression of germination occurs on parts of the film pressed between soaked filter papers, or certain minerals of similar wetness, or autoclaved soil, which last, in fact, stimulates germination as compared with the 'margins'. When the 'folds' from living and autoclaved soils are exchanged after a few days, germination proceeds on the first, and hyphal growth is checked on the second.

Kaolin, alumina and slate dust have been found to reduce, but never to extinguish, germination in the 'folds', as compared with soaked filter paper, sand and silica, which allow of normal germination; but this reduction is absent when the film is not folded, being merely pressed down firmly on the moist soil. Under these conditions, the inhibition is fully shown with normal soils, provided that precautions are taken to secure good contact and to prevent condensation on the exposed test surface. Similarly placed agar films have so far given inconclusive results, for though some inhibition is exhibited, its interpretation is complicated by the growth of hyphæ from the soil into the agar. The inhibition has been demonstrated with a somewhat thicker cellulose film (about 40 μ), but was apparently not present when the thickest film obtainable (about 120 μ) was used. It has also been demonstrated in the natural soil out of doors; but most of the tests have been carried out in glass dishes in the laboratory, the 'margins' being used as controls.

The normal test period is four days at room temperature though some 'folds' have been kept in the soil for as long as five weeks without germination of the spores; but more often results are obscured after a few weeks by bacterial, insect or mite attack on the film, especially if the inside of the 'fold' is contaminated with soil. If the sweet dressing commonly present on commercial cellulose film is not completely removed by boiling in water, a breakdown of the inhibition, accompanied by bacterial growth, may occur within a few days.

A strain of *Penicillium frequentans* Westling isolated from forest soil and having a high percentage germination in water was chosen as the main test organism. Up to the present the test outlined above has been applied to soils from fifteen sites in North Wales and one in Warwickshire, as well as subsoils from several sites.

Complete inhibition was found in every sample of fresh soil tested. These soils may be summarized as follows: *Forest soils*, 5; under Norway spruce, beech, sycamore (2) and oak. The first two have been tested at every level down to mineral soil at 1 ft. The half-rotted litter both of spruce and beech possesses the inhibiting effect. *Grassland soils*, 5; waste ground, rough grazing over acid igneous rock, a moderately good grass ley, drift material at 1 ft. under mown turf, and a calcareous turf over carboniferous limestone (Anglesey). This last was tested down to broken limestone at 6 in. *Cultivated garden soils*, 3; poor, average, heavily composted (from Warwickshire); also John Innes potting compost. *Waterlogged soils*, 3; fresh mud from a spring, black decaying pool-bottom material, calcareous peat brought up from levels down to 3 ft. under standing water (Llyn Cadarn, Anglesey). *Two subsoils* also showed complete inhibition: a stiff clay from 3 ft. depth near a garden compost heap, and the finer fractions of a gritty subsoil at 2–2½ ft. depth from a building excavation on a formerly wooded site.

Incomplete inhibition, allowing germination of a minute, fractional percentage of spores compared to controls, was found in three subsoils: drift material at 2 ft. and 3 ft., stony subsoil augered from 3½ ft. under rough pasture over acid, igneous rock, a similar material from 3 ft. to 4 ft. depth from a drain excavation under a wide path.

Germination, not less than that shown with kaolin, has been found, so far, in drift material at 6-ft. depth, and in four samples of gritty subsoil from depths of 3 ft. to 20 ft., sent by Mr. J. Goodwin from an open-cast coal mine near Aberdare, Glam.

The four samples described as 'drift material', which was a silty, mottled clay showing signs of impedance, form a series in depth taken from one pit. The samples were almost indistinguishable in appearance, except that the uppermost, at 1 ft., showed traces of fine roots. This showed complete inhibition. With the 2-ft. sample, an occasional germ tube could be found, after a search. At 3 ft. there were a few more, but still too few to estimate as a percentage. At the 6-ft. level about 5 per cent of the spores germinated. The 1-ft. sample, after autoclaving, stimulated germination, whereas autoclaving made no change in the test results given by the 6-ft. sample.

The inhibition was not shown by three old dried soils, kept in bottles for periods up to twenty years. These, when moistened, became mouldy in a manner resembling autoclaved soils. The effect was present in a clod of forest soil which had been air-drying at room temperature for six weeks, but had disappeared by the seventh week, though it was then still present in another clod which lay beside it. Stored, powdered slate dust gave a rather poor germination which was not improved by autoclaving the material.

The following results have been obtained with the forest soils originally investigated, and with *P. frequentans* as test fungus:

The inhibitory effect is not removed by repeated leaching with distilled water, nor by percolating for seven days. In neither case does the water acquire the effect. It appears to be present to some extent in pressed-out soil water, but preliminary results are inconclusive, and even more so for Seitz-filtered sterile extract. The effect disappears completely from soil shaken up for five minutes and washed through a funnel with citrate–phosphate buffer solutions at *p*H values of 4–7·5, but remains after similar treatment with a phosphate buffer series from *p*H 4·5 to 8, and even after hydrochloric acid at *p*H 1, the soil being returned to *p*H 5–6 by washing before test. The citrate-treated samples afterwards grew moulds. The effect is lacking from the filtrates in every case.

When the soil is moistened with dilute solutions of glucose plus inorganic salts germination takes place, though it is less than on the control margins. This occurs even with a trace of glucose, as little as 0·1 per cent; but if a fresh test 'fold' is inserted after three days, the inhibition is found to have returned, though not completely in the case of the strongest solution used (4·4 per cent) with which a few spores germinated. A similar series set up with asparagin (plus salts) solutions from 0·1 to 2 per cent showed no germination except with the 2 per cent asparagin which gave a very few germ tubes.

Moist, sieved soil, tubed and immersed in a water bath for one hour at 40°, 50° and 60° C., showed full inhibition after 40° C., stimulated germination after 60° C., and an intermediate result with about 50 per cent of the control germination after 50° C. Soil exposed to ether vapour for twenty-four hours gave stimulated germination; but the inhibition restored itself after three days. Wetting with acetone also removed the inhibition, but a prolonged washing in a shaker with distilled water for 13½ hours restored it. Plating out showed that neither of these treatments had completely sterilized the soil. An intimate mixture of 10 per cent by weight of finely divided charcoal with soil completely removed the inhibition, and the mixture afterwards grew moulds on the surface. The inhibitory effect is not restored in a short time by re-inoculation of autoclaved soil with fresh soil, nor by exposure of dried soils to atmospheric infection. A re-inoculated sample of autoclaved garden soil still lacked the effect after two months, and of forest soil after four weeks. The test species usually spores freely on the surface of these soils; but germination remains uninhibited during this growth and after it has died down. A test over potash showed that carbon dioxide is evolved more rapidly by autoclaved soil during this phase of mould growth than by a control of unautoclaved soil possessing the inhibitory effect.

Up to the present the fungi tested have been, with a few exceptions, those isolated from the original forest soils. A random mixture of spores from the colonies on a soil plate was completely inhibited by the soil from which they were cultured. The following species have been tested separately and found to be inhibited: *Penicillium frequentans* Westling, *P. expansum* Link, *P. nigricans* (Bainier) Thom, *P.*

commune Thom, *P. waksmani* Zaleski, and ten other species not all fully identified, including some from each division of the genus; *Cladosporium herbarum* Link ex Fr., *Trichoderma viride* Pers. ex Fr., *Macrosporium* sp., *Chætomium globosum* Kunze (ascospores), *Mucor hiemalis* Wehmer, *Mucor plumbeus* Bonorden, *Mortierella ramanniana* (Möller) Linnemann, *Mortierella bainerí* Costantin, *Rhizopus nigricans* Ehrenberg.

Most of these are 'sugar fungi'; but *Chætomium globosum* attacks cellulose. So far no fungus tested has been able to germinate or grow on the soil-contact area; but that such fungi exist seems probable from casual observations. With one soil (composted garden loam from Warwickshire) a dense growth of sterile mycelium was found on the outside of the 'fold', and various sterile mycelia, some of them bearing clamp connexions, have been seen in some of the soils used; but the test method has not yet been satisfactorily adapted to such mycelia, nor to spores which require nutrient or other special conditions for germination.

The evidence here presented is insufficient to identify the factor causing the inhibition; but it does seem to differentiate it from most of the antibiotics produced by micro-organisms, the production of which is usually stimulated by the presence of carbohydrates. In the case of patulin, one of the antibiotics shown to be produced in soil, Grossbard[6] found that, even in sterilized soil, the addition of carbohydrates was necessary for its manufacture by *Penicillium patulum*. Gregory, Allen, Riker and Petersen[7] have demonstrated antibiotic activity in unsterile soil supplemented with organic matter, and Wright[8] has shown that gliotoxin can be produced by *Trichoderma* in unsterilized Wareham Heath soil, but only with addition of dried clover. Jefferys[9] has shown that inactivation of gliotoxin is more rapid in neutral garden loam than in the acid Wareham Heath soil and that a number of antibiotics have a limited range of stability as regards *p*H. Hessayon[10] has shown that trichothecin can be produced in unsupplemented, sterilized soil; but this antibiotic is remarkably thermostable, and possesses other distinctive features.

Since this article has gone to press, Hessayon[11] has reported that spores of *Trichothecium roseum* fail to germinate in unsterilized soils, although growth of a mycelial inoculum takes place; and also that a factor inhibitory to the growth of *T. roseum* is present in the ether extract of unsterilized soils.

The indications of the work at Bangor are that there exists in the soil a widespread fungistatic factor, which, from its distribution in depth, possibly coexists with some organic constituent of the soil. It seems to be masked, rather than destroyed, by the presence of glucose even as a trace, or of nutrients liberated from micro-organisms killed by heat or toxins, since it returns, presumably when the nutrient has been absorbed by other micro-organisms in the soil; but it may be removed by severe heating or prolonged desiccation, as it is then not rapidly restored. The only comparable phenomenon hitherto described appears to be that found in Wareham Heath soil by Rayner and Neilson-Jones[12]; but that effect, usually regarded as toxic, is so strong that it inhibits the growth of moulds on the surface of nutrient agar containing citric–phosphate buffer, and may even be lethal to mycelium. Nevertheless, it has great similarity to the effect described here in its apparent instability apart from the soil, and its behaviour after partial sterilization of the soil. The finding by Neilson-Jones of some fungitoxicity in the more normal Oxshott Heath soil is also significant. It is premature to speculate on the relationship between these two phenomena; but they must surely fall into the same general class. Despite the intensive work of Brian[13] and his colleagues, mainly on the antibiotics produced by organisms isolated from Wareham Heath soil, that phenomenon has not yet been traced to its source, and it will not therefore be surprising if this more widespread, but subtler, effect fails to yield up its causal factors, biological or biochemical, soon or easily. For this reason it seems advisable to publish these results at this preliminary stage, especially as the phenomenon may well prove to be generally present in soils and to fill a significant gap in the puzzle-picture which confronts the soil mycologist.

That spores must lie dormant in soil is an inescapable deduction from the fact that they germinate in large numbers whenever soil is placed in contact with nutrient media; but that the nutrient is not necessarily responsible for their germination is clear from the fact that many spores germinate in distilled water. In recent years it has been widely realized, as pointed out by Garrett[14], that soil dilution plates of the classical type designed by Waksman[15] greatly favour the heavily sporing 'sugar fungi', and techniques, such as those of Chesters's[16] immersion tubes and Warcup's[17] soil plates, have been devised to minimize this effect. There can be no doubt that these methods isolate mycelia where such are present; but unless any given isolate can be shown to be able to grow in the habitat from which it was obtained, there is no likelihood that it was present there in active mycelial form. With regard to those common isolates which can be shown to be subject to inhibition of germination in the soil, it is doubtful whether we are entitled to refer to them as members of the soil flora. Perhaps it might be better to borrow the term which P. H. Gregory applies to air-borne spores, and to refer to them as the soil 'spora'. So far as these fungi are concerned, if they grow in the soil at all, as many of them almost certainly do, it must be in special habitats forming 'islands' in the sea of inhibition. So far as present indications go, such habitats may be formed by some, though not all, organic materials, including nutrients liberated from soil organisms dying or killed by various means such as, for example, long drying or insolation at the surface. Such habitats may provide sufficient nutrient for sporulation. It is possible also that occasionally germination and limited growth may occur in freshly brought up subsoil and in condensed or rain water which has not mixed with the soil; but in the absence of nutrient such germlings would generally die without sporing. Susceptibility to the inhibition is likely to have a high survival value for fungi with spores which germinate in water without nutrient.

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LETTERS TO THE EDITORS

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Production by Cosmic Rays of Helium-3 in Meteorites

The helium content of iron meteorites varies from less than 10^{-9} c.c. to 4×10^{-5} c.c. per gm. [1]. Since their uranium and thorium content is fairly constant, this variation was considered as an indication of their very different ages. During the past decade, however, it has been discovered that by the impact of cosmic rays on matter helium is formed, and Bauer[2] and Huntley[3] have pointed out that a considerable part of the meteoritic helium might have this origin. Although attempts to calculate this amount on the basis of our published figures and of certain assumptions about the masses of meteorites[4] were open to criticism[5], it was predicted[6,7] from cosmic ray observations that in meteoritic helium the proportion of helium-3 to helium-4 may amount to about 30 per cent, and in five iron meteorites helium-3/helium-4 ratios varying from 17·8 to 31·5 per cent were found[8].

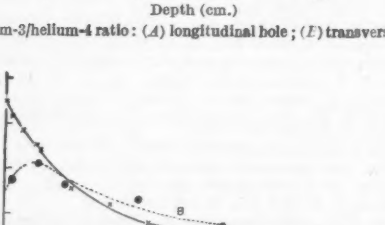
These results were considered as proving the cosmic ray origin, in the meteorites richest in helium, of the helium-3 and most of the helium-4; but various questions concerning the mechanism of the helium formation by cosmic rays and the relative amounts of the two helium isotopes thus created remained undecided[9]. It seemed promising to study the dependence of the helium content of meteorite samples on their distance from the surface. Owing to the attenuation of cosmic rays inside the meteorite, a 'depth effect' ought to exist, if the helium was formed by these rays. Several attempts to discover such an effect were unsuccessful[9,10], and it became clear to us that one could hope to detect it only in samples from the interior of a very big rounded iron meteorite with accurately measurable helium content. The 1,200-lb. mass of the Carbo meteorite[11] in the Museum of the Mineralogical Department of Harvard University looked promising, and the curator, Dr. C. Frondel, kindly agreed to have samples collected from various depths by two bore-holes extending right to the centre.

The extraction of helium from the Carbo drillings and its purification and measurement were carried out by the methods described elsewhere[12]. To facilitate handling in the mass spectrometer, each helium sample of 10^{-4} c.c. (N.T.P.) was diluted with about 10^{-2} c.c. (N.T.P.) of argon and sealed in a glass tube with a break seal. To introduce the gas into the spectrometer the seal was broken, and the gas compressed into the sample reservoir to obtain a convenient ion-beam strength. Standard samples of helium-3/helium-4 mixture were run at the commencement and end of each working period.

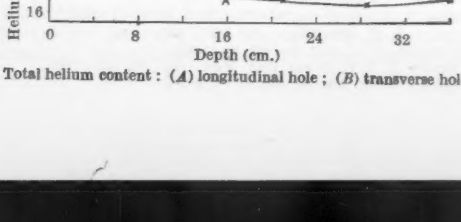
The results of our measurements can be seen from the accompanying table and graph. The precision of the manometric helium values is about ± 0·1 per cent, of the mass-spectrometer values better than ± 1 per cent of the helium-3/helium-4 ratio. It is not yet possible to give a full explanation of the details of the curves; but the main results are as follow.

Depth (cm.)	Helium content ($\times 10^{-6}$ c.c./gm.)	Helium-3 / Helium-4 (per cent)
	Longitudinal hole	
0	23·03	—
0·5	22·30	28·4
1·5	21·70	—
2·5–3	21·06	28·8
3	20·81	—
6	19·05	28·8
9·5	18·53	28·5
13	17·60	—
17	17·24	27·8
21	17·04	—
28·5	16·83	27·7
36	17·13	—
	Transverse hole	
0·5	19·45	28·3
3	20·25	28·9
5·5	19·24	—
6	19·01	—
12	18·64	28·7
19·5	17·50	28·1

Both the total quantity of helium and the percentage of helium-3 change regularly with depth and are smallest in the interior. The highest values for the helium-3/helium-4 ratio are found a few centimetres below the present surface of the meteorite; this is most probably a consequence of the lower energy α-particle component of the primary cosmic radiation being brought to rest within a few centimetres of the surface[7]. In one of the bore holes also the total quantity of helium increases slightly over the first few centimetres and then decreases towards the centre; for this effect irregularities in the shape of the meteorite present during the period of its cosmic irradiation may be responsible, or, alternatively, it may reflect the eccentric position of the present mass inside the original one. We hope to be able to say more about the original form of the meteorite after analysing samples from a third bore hole drilled right through the meteorite which Dr. Frondel has kindly agreed to provide. We think it less likely that a diminution of the uranium or thorium content of the meteorite near this part of the surface is the cause of the helium decrease; we did not find any marked variation of the uranium content. (In a sample from the surface, $0{\cdot}52 \times 10^{-6} \pm 0{\cdot}02 \times 10^{-6}$ gm. per gm.; from the interior, $0{\cdot}56 \times 10^{-6} \pm 0{\cdot}04 \times 10^{-6}$ gm. per gm. The material at our disposal was not sufficient to determine the thorium in the drilled samples; near the surface we found $0{\cdot}63 \times 10^{-6} \pm 0{\cdot}42 \times 10^{-6}$ gm. per gm. [13].)



Helium-3/helium-4 ratio: (*A*) longitudinal hole; (*B*) transverse hole



Total helium content: (*A*) longitudinal hole; (*B*) transverse hole

It is not yet possible to say how much of the helium-4 in the Carbo meteorite is of radiogenic origin, since the quantity of helium-4 produced by cosmic rays together with helium-3 is not accurately known[6,7] and depends on the relative proportions of the primary and secondary radiations. From observations on another meteorite, we concluded[8] that there the helium-4 of cosmic ray origin could not be more than 3·2 times the helium-3; the limit derived for the Carbo meteorite is 3·5. The possibility of determining the quantity of radiogenic helium on which to base an age calculation is obviously much greater in meteorites with a low helium-3/helium-4 ratio[6,8].

The fact that the helium-3 content, even at a depth of about 30 cm., is only 27 per cent smaller than near the surface of the Carbo meteorite confirms present-day views about penetrating power and the action on matter of cosmic rays[9].

Experimental details and discussion of our work will be published elsewhere.

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Avidity of Terramycin and Aureomycin for Metallic Cations

It has been shown that the antibacterial action of 8-hydroxyquinoline is due to its ability to combine with ferrous, ferric and cupric ions accidentally present in the medium, the complexes thus formed being the true toxic agents[1].

It is therefore interesting to discover that terramycin and aureomycin also have high affinities for metallic ions. These affinities were put on a quantitative basis by potentiometric titration at 20° (with potassium hydroxide) of the chemically pure monohydrochlorides of these substances (0·001 *M*) in the presence of various metallic salts (0·0005 *M*) (0·00033 *M* for Fe^{3+}). Preliminary experiments had shown the formation, first of a 1 : 1-complex, and later, as the *p*H rose during titration, of a 2 : 1-complex, that is, one containing two molecules of the antibiotic to one atom of metal. Details of the titrations and the calculations were similar to those published for 8-hydroxyquinoline[2]. The results are given in the accompanying table, where K' refers to the 1 : 1-complex and K_s is the product of all the partial constants (of which a divalent ion has two and a trivalent ion three).

Stability Constants for Metallic Complexes

Metallic cation	Terramycin			Aureomycin		
	log K'	log K^*	log K_s	log K'	log K^*	log K_s
Fe^{3+}	9·1[a]	7·2	22·0[b]	8·8[a]	7·2	21·6[a]
Cu^{2+}	7·2[a]	5·0	12·2	7·6[a]	5·0	12·6
Ni^{2+}	5·8	4·8	10·6	*d*	*d*	*d*
Fe^{2+}	5·6	4·8	10·4	5·7	4·7	10·4
Co^{2+}	5·1	*e*	(9)[f]	4·8	*e*	(9)[f]
Zn^{2+}	4·6	*e*	(8)[f]	4·5	*e*	(8)[f]
Mn^{2+}	4·3	3·7	8·0	4·3	*e*	(8)[f]

(*a*) In these cases, the affinity was so strong that this first constant could only be obtained by back-titration with hydrochloric acid (4 equiv. in the case of Fe^{3+}).
(*b*) (*c*) These values include a log K''' of 5·7 and 5·6 respectively, three molecules of the antibiotics eventually becoming bound to this trivalent cation.
(*d*) Not attempted because of shortage of pure material.
(*e*) Precipitation of highly insoluble 2 : 1-complexes prevented readings being obtained.
(*f*) Deduced values (approximate).

Before these titrations could be undertaken, the ionization constants of the antibiotics had to be determined under similar experimental conditions. The terramycin was dried at 75° and 0·02 mm.; the aureomycin at 110° in air. The pK_a values for terramycin (0·001 *M*) were 3·10 (± 0·02); 7·26 (± 0·02) and 9·11 (± 0·03); and for aureomycin (0·005 *M*) 3·30 (± 0·02); 7·44 (± 0·01) and 9·27 (± 0·03), which are similar to the approximate values previously reported[3]. The values near 3 represent the ionization of cations, the others of anions. Trial calculations[4] showed that combination with metals required that the groups near pK_a 7 should be ionized but that those near 3 and 9 should not be ionized.

It is seen from the table that the constants for terramycin and aureomycin are almost identical within experimental error. These constants, and the order of preference for the various metals, are much the same as in the common amino-acids[4,5] with two important exceptions; (i) the position of Fe^{2+} is here elevated above its usual position between Mn^{2+} and Zn^{2+}, and (ii) Fe^{3+} is the most strongly bound ion, whereas amino-acids have little or no affinity for it[4,5].

It is interesting to note that the powerful antibacterial, 8-hydroxyquinoline, also combines preferentially with ferric iron; however, all the constants for terramycin and aureomycin are considerably lower. Moreover, because 8-hydroxyquinoline is inactivated by red blood cells, the comparison ought not to be pressed at this early stage of the investigation.

The copper and nickel complexes of these antibiotics were found to be green, the ferrous and ferric complexes red, and the others yellow. Unlike the free antibiotics, the complexes caused foaming when their solutions were agitated.

I thank Mr. E. P. Serjeant for technical assistance; Miss G. Hobby (of Chas. Pfizer and Co., Inc.) for a gift of chemically pure terramycin, and Dr. S. D. MacIsaac (of Lederle Laboratories Division of Cyanamid Products, Ltd.) for a gift of chemically pure aureomycin.

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Isolation of Thorium B (Lead)-binding Substance from the Erythrocytes of Rabbit Blood

The distribution of lead in blood fractions has been investigated by several workers. Recent studies made by using lead salts labelled with thorium B [1,2], and with radium D [3], showed that the lead is mainly held by the erythrocytes. The present communication deals with the isolation of the component mainly responsible for the uptake of thorium B by the erythrocytes.

The method of activating blood with thorium B was essentially the same as that described by Alexander[2]. An oxygen stream striking the surface of radiothorium was led into 20 ml. freshly drawn rabbit blood (heparin was used as an anti-coagulant) for 30 min. After activating, the blood was shaken for 30 min., since the maximum uptake of thorium B by the erythrocytes takes place during this process[1,2].

The active blood was centrifuged and the plasma removed. The erythrocytes were washed thrice with an equal volume of cold 0·9 per cent sodium chloride. The washed erythrocytes were chilled. To the chilled mass, an equal volume of cold distilled water and an equal volume of cold ether were added and mixed well and centrifuged. The clear hæmolysate was drawn out with a capillary. When the hæmolysate was dialysed against distilled water, it was found that 61 per cent of the thorium B present in it was in a non-dialysable form and the rest was in a dialysable form. To the hæmolysate at 0° C., one-third its volume of absolute alcohol at − 10° C. was added. It was kept in the ice chest for 30 min. and centrifuged. The precipitate was washed with cold 25 per cent alcohol until the last washings were colourless. The precipitate was found to be fifteen times more active than the same weight of hæmolysate. The precipitate was insoluble in water, in mineral acids and 0·9 per cent saline, but was soluble in $N/50$ sodium hydroxide up to about 0·5 per cent. The biuret, Millon–Nasse, xanthoproteic and ninhydrin tests were positive. With Benedict's reagent it gave a green precipitate; but no sugars were detected when the material was subjected to paper chromatography according to the method of Partridge[4]. It had a very weak blood group B specificity when tested according to the method of Bray *et al.*[5].

The precipitate was dissolved in 10 ml. $N/50$ sodium hydroxide and the protein was denatured by shaking with Sevag's reagent. It was shaken with 2 ml. of the reagent, a mixture of chloroform and n-butanol (10 : 1), for 30 min. and centrifuged. This operation was repeated several times until the supernatant solution gave no reaction with ninhydrin. The active component was precipitated by passing carbon dioxide for 10 min. into the protein-free supernatant solution. The precipitate, separated by centrifugation, retained all the activity present in the supernatant solution. The precipitate was insoluble in water but was soluble in $N/50$ sodium hydroxide. It was dissolved in 10 ml. $N/50$ sodium hydroxide, and a few drops of ammonium hydroxide were added and then precipitated with 20 per cent lead acetate. The lead salt was washed four times with 5 ml. of distilled water each time and once with absolute alcohol. It was dried *in vacuo* over anhydrous calcium chloride. The analyses of the lead salt, kindly performed by Dr. Simon (Heidelberg), were: C, 35·95; H, 4·88; N, 12·14; Pb, 26·08 per cent. 30 mgm. of the lead salt was suspended in 9 ml. of distilled water, acidified with 6N hydrochloric acid, hydrogen sulphide was passed to saturation and the suspension centrifuged. The supernatant solution was freed of hydrogen sulphide by bubbling nitrogen into it. It gave a positive Millon–Nasse reaction and a white precipitate with bromine water. It gave an orange colour with diazotized p-nitroaniline[6] and a blue colour with phosphotungstic–phosphomolybdic reagent[7]. These results suggest that the non-protein component is most likely a phenolic compound.

It appears from the above that the substance which is responsible for the uptake of 70 per cent of the non-dialysable thorium B present in the hæmolysate consists of a protein and a non-protein component. The non-protein component is most probably a phenolic compound.

Full details of this investigation will be published elsewhere. I wish to thank Prof. G. de Hevesy for his interest and encouragement during the course of this investigation.

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Fixation of Radioactive Colchicine by Ehrlich Ascites Carcinoma Cells

In this communication we wish to report briefly some results on the fixation of radioactive colchicine by the cells of the ascitic form of Ehrlich carcinoma, which is one of a number of tumours used by us in our work with radioactive colchicine.

Ehrlich ascites carcinoma, known since 1932 [1], and recently described in detail by G. Klein[2], consists of a suspension of discrete tumour cells floating in ascitic fluid. This type of tumour was found by us to be well suited to study the fixation of radioactive colchicine by individual cells, as their number can easily be counted, and the use of radioactive colchicine affords a sensitive and accurate method of measuring the amount of the drug present in tumour cells.

Table 1. Number of Molecules of Radioactive Colchicine per Cell in Relation to Injected Doses

Exp.	No. of animals	Dose of colchicine given (mgm.)	Total number of ascites cells (millions)	Molecules per cell (calculated)
1	1	0·5	146	$4·6 \times 10^6$
	2	0·5	277	$7·0 \times 10^6$
	3	0·5	226	$7·2 \times 10^6$
	4	1·0	316	$5·8 \times 10^6$
	5	1·0	400	$5·1 \times 10^6$
	6	1·0	550	$5·3 \times 10^6$
	7	1·5	380	$7·3 \times 10^6$
2	1	1·24	436	$10·0 \times 10^6$
	2	1·24	102	$3·6 \times 10^6$
3	1	1·24	407	$13·5 \times 10^6$
	2	1·24	480	$17·9 \times 10^6$
	3	1·24	568	$3·4 \times 10^6$

Table 2. FREQUENCY DISTRIBUTION OF RADIOACTIVE COLCHICINE PER CELL

	No. of molecules fixed by a single cell in a preparation:			
	0·1–5·0 × 10^6	5·1–10·0 × 10^6	10·1–15·0 × 10^6	15·1–20·0 × 10^6
0·5 mgm. colchicine injected	2	3	–	–
1 mgm. colchicine injected	2	19	4	3
1·2–1·5 mgm. colchicine injected	3	2	2	–
Total	7	24	6	3

White Swiss mice of 20–25 gm. weight bearing well-developed Ehrlich ascites tumours 7–10 days old were used. The radioactive colchicine was injected in a single dose intraperitoneally, thereby ensuring direct mixing with the ascites. The dose administered varied from 0·2 to 1·5 mgm. per animal. After four hours the animals were sacrificed, the ascites withdrawn with a syringe, and the cells counted by the red-cell counting technique. The cells were then separated from the fluid by centrifugation, quickly washed and recentrifuged; then they were extracted for their colchicine content by a method described previously by us[3].

Knowing the specific activity of the injected drug, we are able to calculate the quantity of colchicine fixed by the cells by measuring the radioactivity with an internal Geiger counter. Since the total number of cells present is known, the amount of colchicine fixed by a single cell is then calculated. By using Avogadro's number per gram molecular weight, we can express our results in number of molecules of colchicine fixed by individual cells.

From the examples given in Table 1, it can be seen that the number of molecules of radioactive colchicine per cell is in a large measure independent of the given dose and of the number of cells present in an ascites. From Table 2 it can be seen that the number of molecules per cell in the majority of cases (60 per cent) is 5·1–10·0 × 10^6.

The variations observed may be attributed in part to the experimental errors as well as to biological variations such as: (1) differences of absorption of colchicine by the walls of the peritoneal cavity; (2) differences in speed of excretion in fæces and urine; (3) differences in size of tumour cells present in ascites.

The small but constant quantity of colchicine fixed by the tumour cells is in accordance with the amount of colchicine needed to obtain a caryoclastic influence on cells, and probably gives a more accurate picture than qualitative methods used heretofore.

In a later and more extensive paper we shall give the results on the fixation of radioactive colchicine by Ehrlich ascites cells *in vitro*, and also results related to localization of colchicine in cells.

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An Unidentified Growth-Factor for Yeast and Hyperthyroid Rats

WE have already reported that acetone extracts of liver contain a factor that stimulates the growth of *Saccharomyces cerevisiæ*[1], and of rats[2]. Liver dried at 110° and finely powdered is refluxed with dry acetone. The acetone extract is evaporated to dryness and the residue re-extracted with water. The growth-factor is thus obtained as a clear yellow solution having a *p*H of 4–5. It is heat-stable, dialysable and is not destroyed by acid or alkali. Part of inactive coloured impurities may be eliminated by passing the extract through a column of activated alumina or animal charcoal. The filtrate is still active and does not give the biuret or ninhydrin reaction.

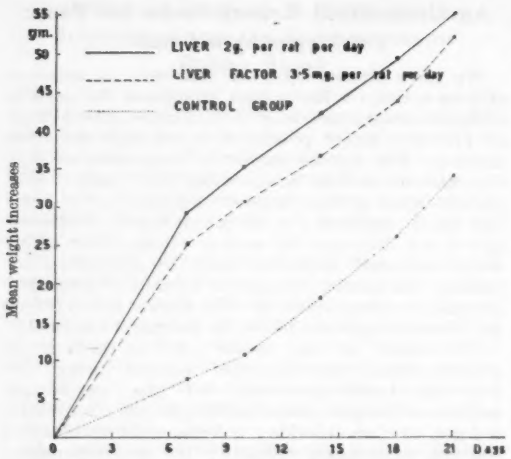
The effect of the factor on the growth of *Saccharomyces cerevisiæ* was studied using the following basal medium: 0·7 gm. magnesium sulphate; 1·0 gm. potassium dihydrogen phosphate; 0·4 gm. calcium chloride; 0·5 gm. sodium chloride; 0·6 gm. ammonium sulphate; 0·1 gm. asparagin; 0·5 c.c. ferric chloride (1 per cent solution); 30·0 gm. glucose; 0·5 mgm. thiamine; 2·5 mgm. nicotinamide; 0·2 mgm. pyridoxin; 0·2 mgm. calcium pantothenate; 5·0 mgm. inositol; 0·01 mgm. biotin; water to 1 litre.

In experiments with an industrial yeast (strain 1*d*/30), we found that 15 μgm./c.c. of the factor doubled the growth after 24 hr. at 30°. The basal medium containing growth-factor was sterilized by steaming for 20 min. The inoculum was prepared by growing the yeast in the basal medium for 24 hr. at 30° and diluting to a concentration of 0·02 mgm. of yeast per c.c. 0·5 c.c. of this suspension was used for each test.

Male albino rats, just weaned, were kept on the diet advised by Györgyi[3] for the assay of vitamin B_{12}. This diet contains soya flour, sugar, vegetable oil, salt mixture and 0·25 per cent of thyroid powder; also a mixture of vitamins comprising thiamine, pyridoxin, nicotinamide, inositol, *p*-aminobenzoic acid and folic acid. After twenty days of depletion, the rats were divided into three groups of ten animals each. The first group served as controls. The rats of the second group received total aqueous extract of liver in a quantity corresponding to 2 gm. of fresh liver a day per rat. The animals of the third group received 3·5 mgm. of the growth-factor a day per rat. The accompanying graph gives the average of the results obtained in three different experiments.

The dose of 3·5 mgm. of growth-factor had an effect only slightly inferior to that of 2 gm. of liver. The effect can scarcely be due to vitamin B_{12}, which is insoluble in dry acetone. Moreover, vitamin B_{12} is destroyed by alkaline hydrolysis whereas the activity of our factor remains practically unchanged after prolonged boiling at *p*H 10; and our factor still caused a good growth response in hyperthyroid rats receiving a vitamin B_{12} supplement (40 μgm. per kgm. of diet).

That liver contains growth-factors in addition to those specifically identified has been known for some years. Recently, Yudkin[4] found that the growth of apparently normal children of two years of age was significantly improved when dried liver was added to a supposedly complete diet. Since our growth-factor is dialysable, it is unlikely to be identical with the factor reported by Dietrich, Monson and Elvehjem[5]. Since it gives no ninhydrin reaction, it is unlikely to be related to strepogenin. Since it does not give a nitroprusside reaction after treatment with



cyanide, it is improbable that it is related to thioctic acid[6]. However, more results must be accumulated before this factor can be correlated with or distinguished from those already reported in the literature, and also to determine whether it is really a rat-growth-factor or an anti-thyroid factor.

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Tryptophane Metabolites in Human Urine

I have already reported[1] that some human urine specimens made strongly alkaline yield distillates presenting spectroscopic and polarographic properties of *o*-aminoacetophenone. This was interpreted as indicating the presence of kynurenine in human urine, since (1) *o*-aminoacetophenone is not present in untreated urine, and (2) no substance other than kynurenine was known to behave in the way described under the condition of experiment. Tabone's interpretation[2], that the source of *o*-aminoacetophenone in human urine is tryptophane, was based on rather different and qualitative experiments.

Although this was made unlikely by quantitative considerations not described in the previous paper, the possibility was investigated further. Tryptophane does give *o*-aminoacetophenone, but in such small yields (about 0·1 per cent) that it could only be a minor source of inaccuracy. When added to urine, it gives even poorer yields, so that quantities between 1–10 gm. would have to be eliminated per day to account for the observed amounts of *o*-aminoacetophenone. On the other hand, it can be readily demonstrated that the urinary substance appearing after administration of 1·5 gm. tryptophane gives usually more *o*-aminoacetophenone than would all the tryptophane administered. The substance should therefore be regarded as a metabolite of tryptophane. In several specimens yielding *o*-aminoacetophenone equivalent to about 0·5 gm. tryptophane, only up to 10 mgm. per 100 ml. was detected by the method of Kraus[3]. Counter-current distribution curves indicate the presence of only one substance giving *o*-aminoacetophenone, and that substance has been found to show certain properties in common with kynurenine: (1) decomposition by alkali to *o*-aminoacetophenone; (2) the same distribution-coefficient in the solvent system (methanol–butanol–water); (3) paper chromatograms of partly purified urine preparations (using butanol–methanol–benzene–water) give a spot of the same colour and position as kynurenine, when developed either with ninhydrin or Ehrlich's reagent.

It is concluded that kynurenine is, without special dieting, present in human urine as the only important source of *o*-aminoacetophenone. The spectrophotometric determination of the latter could then be used for estimating urinary kynurenine, provided analytically satisfactory conditions can be found. The procedure originally described was improved with that purpose, to give almost quantitative (95 per cent) and constant recovery figures. The technique, which will be described in detail elsewhere, eliminates the interference of another substance and makes possible its simultaneous quantitative determination. This second compound is formed by the action of alkali from an acidic precursor which appears in urine especially after administration of tryptophane. Spectroscopic evidence indicates that it is a substituted aniline, but it will be referred to here as substance *B*. The concentration of both substances in normal persons and mental patients was very small (of the order of 0·2 mgm./100 ml. urine). Usually either kynurenine or substance *B* is excreted, and seldom both in comparable amounts. When animal protein is eliminated from the diet, excretion of kynurenine gradually decreases, often to be replaced by excretion of substance *B*. Of the vitamins administered, nicotinamide appeared to increase excretions of substance *B* without affecting that of kynurenine.

The study of the pathological significance of tryptophane metabolism is complicated by the influence of diet. However, a tendency to unusually high excretion of kynurenine was observed in a number of patients with conditions associated with cachexia, such as cancer. High excretion of substance *B* was found occasionally in these patients, but much more commonly in conditions associated with muscle inactivity.

The present study is being extended to the isolation, in sufficient quantities, and purification for classical analysis, of the urinary metabolites and their distillation products. The influence of diet is to be further investigated and results accumulated for correlating the analytical results with other laboratory findings and clinical diagnosis or progress of the disease.

I am indebted to the National Cancer Institute of Canada for the grant covering the expenses of these investigations.

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Substances in Bone-Marrow Extract accelerating Coagulation of the Blood

THOUGH previously it has been known that bone marrow contains a hormone-like substance which has an accelerating action upon the blood coagulation[1], its chemical nature has remained unclarified. We have now investigated this problem. Bone marrow from long tubular bones of domestic fowls, after removal of lipids with alcohol, acetone and ether, was extracted with physiological saline and then the extract was deproteinized with sulphosalicylic acid. After removal of excess sulphosalicylic acid with calcium carbonate, the filtrate was concentrated to a small volume. This filtrate showed a remarkable accelerating action on the blood coagulation.

Attempts were then made to separate the active fraction by several methods (absorption, fractionating precipitation with chemicals, etc.) and finally by paper chromatography. The active concentrate was chromatographed on No. 50 Tōyō filter-paper strip (2 cm. × 40 cm.) or on wider paper (40 cm. × 40 cm.) using water-saturated *n*-butanol as the developer (ascending method), and the spots or the bands were observed under ultra-violet light (2537 A.). As shown in the accompanying diagram, three spots, *A*, *B* and *C*, with R_F values of 0·13, 0·26 and 0·38 respectively, and another spot with R_F 0·86 showing a light purple fluorescence, were detected. Moreover, six spots with R_F values of 0·01, 0·05, 0·10, 0·16, 0·29 and 0·33 were detected with ninhydrin, indicating the presence of several amino-acids.

All these bands were cut out separately in nine strips and, after elution with water, each eluate was used in animal experiments for investigating its physiological action. The eluates from *A* and *B* bands distinctly accelerated blood coagulation, while the remaining seven fractions showed no activity.

Fraction *B*, which gave no sugar reaction, proved to be hypoxanthine (see table), because it showed the same R_F value as that of hypoxanthine in water-saturated *n*-butanol and in the two-phase solvent system of 5 per cent potassium dihydrogen phosphate and *iso*amylalcohol (2 : 1), and its ultra-violet absorption spectra in acid and alkaline solutions were identical with that of hypoxanthine. Fraction *A* separated into spot A_1, with R_F value 0·60, and spot A_2, with R_F value 0·69, on developing with the two-phase solvent system of Carter[2]; these R_F values are identical with those of inosine and guanosine respectively. Both fractions A_1 and A_2 gave the orcinol hydrochloric acid reaction[3] and yielded guanine and hypoxanthine respectively on hydrolysing with diluted sulphuric acid.

		Spot *A*		*B*	Guanosine	Inosine	Hypoxanthine	Guanine
		A_1	A_2					
(1) R_F values using *n*-butanol system		0·13	0·13	0·26	0·12	0·14	0·26	
(2) R_F values using two-phase system		0·60	0·69	0·53	0·60	0·69	0·53	
(3) R_F values after hydrolysis (*n*-butanol system)		0·05	0·26	0·26	0·05	0·26	0·26	0·05
(4) Orcinol hydrochloric reaction		+	+	−	+	+	−	
(5) Absorption maxima ($m\mu$)	pH 1·0	250		248·5	250		249	
	7·0			250			250	
	10·0			261·5			261·5	

In physiological tests using a modified method of Sahli–Fonio with rabbits as test animals, authentic samples of hypoxanthine and guanosine distinctly accelerate the blood coagulation in doses of 200 γ for a rabbit weighing 2·0 ~ 2·5 kgm. The activity of inosine seems a little weaker than that of hypoxanthine or guanosine.

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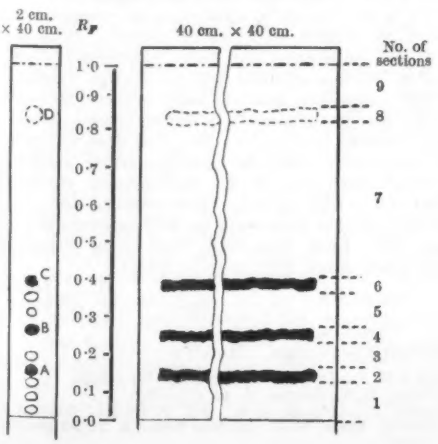

Sub-Diploid Chromosome Variation in Man and other Mammals

THE existence of sub-diploid chromosome numbers in the somatic tissues of mammals has for long been a matter of controversy. This had centred around several earlier reports of the normal occurrence of many somatic cells with less than the diploid number of chromosomes. The controversy has again been recently revived by reports[1] that the human uterine endometrium normally contains cells with varying numbers, ranging from 4 to 104, of chromosomes. The highest frequency peak of these numbers is supposed to lie in cells with 20–25 chromosomes, with a much lower peak in cells with 45–50 chromosomes. It is also suggested that this type of chromosome variation may be a distinct characteristic of warm-blooded animals.

The existence of cells with more than the diploid number of chromosomes would not be a unique occurrence, as different degrees of polyploidy can be present in various tissues. It has also been shown

that genetic abnormalities of mitosis can produce some sub-diploid variation[2]. But the normal existence of such a large proportion of sub-diploid and particularly of sub-haploid cells within the same tissue would be a fact of special interest.

In order to check on this reported chromosome variation, I have examined the chromosome numbers in cells of the human uterine endometrium. As further controls, the normal uterine endometrium of *Rattus norvegicus* (laboratory albino rat) with $2n = 42$, and of *Microtus agrestis* (short-tailed bank vole) with $2n = 50$, have also been examined. The rodent *Microtus agrestis* is especially favourable for somatic chromosome studies since the two sex chromosomes are considerably larger than any of the 48 autosomes and they can be readily identified during the stages of mitosis[3].

In both the present and Timonen's[1] observations, the cytological study was based on the use of Feulgen squashes. This technique can give satisfactory results for mammalian chromosomes[4]. But in making such preparations, one has to be very careful that the cells have not been damaged by the squashing. In the scoring of chromosome numbers, I have therefore taken particular care that no damaged cells were included. All chromosome counts have been made with an accuracy of about 5 per cent of the chromosomes or even better. Fifty cells were scored in each of the three species, and these have shown no variations from the normal diploid chromosome numbers. In addition, it was clear from the appearance of many dividing cells which could not be so accurately counted that there is no extensive sub-diploid variation.

Some reductions in chromosome number as a result of such mechanisms as lagging, non-disjunction, or an occasional multipolar spindle, may normally occur in some somatic cells. Multiples of the diploid number may also occur. But there is no indisputable evidence of extensive sub-diploid variation as the usual constituent of normal somatic tissues.

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An Irreversible Choline-esterase Inhibitor in White Clover

In the course of a study of the decomposition products of radioactive octamethylpyrophosphoramide in white clover (*Trifolium repens*, strain *S*100) it was found incidentally that extracts from clover, whether previously treated with this compound or not, inhibited choline-esterase *in vitro*.

Clover samples were macerated with water, the macerate extracted with chloroform (equal volume) and the chloroform extract evaporated nearly to dryness under vacuum. Water was then introduced, the remainder of the chloroform distilled off, and the aqueous solution filtered free of the chlorophyll precipitated. The anticholine-esterase activities of the aqueous products from untreated clover were found by Michel's method[1], using freeze-dried plasma. The aqueous products from treated clover were evaporated under vacuum in the presence of trichloroethylene, thus obtaining chlorophyll-free solutions in this solvent of the chloroform extractables without subjecting them to a temperature above 20° C. or to prolonged contact with water. The trichloroethylene solutions were then chromatographed on a kieselguhr column, with a water standing phase and a 30 per cent chloroform : 70 per cent trichloroethylene (v/v) moving phase. The eluent fractions were tested for anticholine-esterase activity as before.

The total anticholine-esterase activity is expressed as the volume of solution in millilitres extracted from 1 kgm. of clover inducing 50 per cent inhibition in a serum solution after incubation for 30 min. at 25·6° C. In these units, four untreated samples gave values of 3,640, 4,550, 640 and 32*; two treated samples, 2,140 and 10,620; and volumes of solvents equivalent to those used in the extractions, 20–30. There are considerable variations. Most are probably to be accounted for by absorption on the chlorophyll precipitated when the chloroform is removed. It was later discovered that, unless special precautions are taken, up to 80 per cent of a low concentration of octamethylpyrophosphoramide may be absorbed by the chlorophyll in this way, and that the amount absorbed is very variable. Probably the inhibitor is similarly absorbed. The starred value is, however, very much lower than the rest. The sample of clover for which this value was obtained came from another field of *S*100 clover in a very different state of growth, and yielded little or no inhibitor.

One active sample was tested by Mr. K. P. Fellowes for *in vitro* activity against human and rat red cell choline-esterase, and for reversibility towards rat cells by the method, slightly modified, of Aldridge[2]. It was about equally active against human and rat red cells as against human plasma, and showed no signs of reversibility after washings equivalent to $6{\cdot}4 \times 10^7$ dilution.

The inhibitor from the treated samples was eluted from the column before the octamethylpyrophosphoramide or any other phosphorus-32-containing band appeared. It therefore separates more readily than these compounds from water into the organic solvents used. Its anticholine-esterase activity was only reduced to a third by the action of *N* sodium hydroxide for 30 min. at 15° C., and was not observably affected by storage in water for one week.

If this compound can be absorbed by animals eating large quantities of clover, it might be expected that they would show some ill-effects. Bloat in sheep and cattle is attributed to cyanogenetic compounds produced by several varieties of clover[3]. It is certain that the substance we have discovered does not inhibit choline-esterase by producing cyanide, as $M/100$ potassium cyanide only induces 20 per cent inhibition in plasma choline-esterase under our experimental conditions; but this does not rule out the possibility that the choline-esterase inhibitor is identical with one of the cyanogenetic compounds. Thus clover may in some cases produce signs of anticholine-esterase poisoning as well as cyanide poisoning. We think, therefore, that these observations may have some relevance to bloat.

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Free Xylose in Fruits

An investigation of the carbohydrates present in the Victoria plum has revealed the presence of small amounts (*c.* 0·1 per cent fresh weight) of free xylose in the juice of ripe and immature fruits. The origin of this sugar is uncertain; it may arise from enzymic hydrolysis of a xyloside, but we consider this unlikely.

The xylose was isolated by maceration of the plum mesocarp, followed by dialysis against distilled water. The dialysate, containing the free sugars, was evaporated to a syrup *in vacuo*, and the xylose isolated by partition chromatography using a cellulose column[1].

The xylose was characterized by paper chromatography (Whatman No. 1 paper was employed) using as solvents ethyl acetate – acetic acid – water (9 : 2 : 2), *n*-butanol – pyridine – water (10 : 3 : 3), and phenol–water (phenol saturated with water). The chromatograms were developed by spraying with 4 per cent anisidine hydrochloride in *n*-butanol[2].

Further proof of identity was obtained by the preparation of a dimethyl acetal dibenzylidene derivative.

Sufficient material was not available for accurate optical measurements, though a preliminary examination showed that it exhibited a small dextrorotation.

Evidence has also been obtained of the existence of free xylose in other varieties of mature plum, damson and quince, and Dr. A. E. Flood and his colleagues have detected it chromatographically in young apple and pear shoots, and in the leaves of potato[3].

It is hoped to continue the investigation when further supplies of fruit are available. We are indebted to Dr. J. K. N. Jones for his advice and interest during this work.

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Amino-Acids in Phloem Sap and their Excretion by Aphids

Some results of the application of paper chromatography to the detection and estimation of amino-acids and sugars in the honey-dew excreted by aphids and coccids have been published recently by Gray[1], Maltais and Auclair[2], and others. What has remained obscure is the relation between the composition of the honey-dew and that of the plant sap on which these insects are feeding.

The determination of the composition of phloem sap, which is the normal food of aphids, was undertaken in 1950. The phloem sap of two- to four-year-old stems of *Salix* spp. was collected as it exuded through the severed mouthparts of the aphid, *Tuberolachnus salignus* (Gmelin), by the method outlined by Kennedy and Mittler[3]. Its chemical composition was compared with that of the honey-dew excreted by aphids feeding on the same stems at the same time. When equal volumes of freshly collected phloem sap and honey-dew were run side by side on chromatograms, it was found that each of the amino-acids which could be detected in the honey-dew was present in the phloem sap. All the amino-acids were in a higher concentration in the phloem sap than in the honey-dew. The chromatograms did not suggest that there was any differential absorption by the aphid of amino-acids from the sap. Acid hydrolysis of samples of sap and honey-dew did not result in any increase in the number or quantities of the amino-acids, other than aspartic and glutamic acids, at the expense of their amides. Quantitative determinations of the total nitrogen in the sap and honey-dew also showed that, over a considerable range of concentrations, the amounts of total nitrogen in the sap were always in excess of those present in the honey-dew.

These results suggest that the nitrogenous matter ingested by an aphid is in the form of free amino-acids and amides, which are usually in excess of the aphid's requirements. The free amino-acids detected in the honey-dew seem to come directly from the ingested sap, and are not to be regarded as products of protein breakdown or of the fixation of atmospheric nitrogen supposedly through the agency of the aphid's symbionts[4].

It was further found that the number and the amount of amino-acids in the honey-dew depend on the extent to which these amino-acids are present in the phloem sap of the plant. The amino-acid composition of the phloem sap depends in turn on the developmental stage of the plant. As shown by Kennedy and Booth[5], certain leaf-feeding aphids colonize growing and senescing leaves in preference to leaves in an intermediate, fully functioning condition. The greatest variety and abundance of amino-acids in the phloem sap of the willow stems were found during the growth and senescence of their foliage. The following amino-acids and amides could then be demonstrated readily both in phloem sap and in honey-dew: aspartic acid, glutamic acid, serine, threonine, alanine, valine, leucine and/or *iso*leucine, phenyl alanine, asparagine, glutamine and, possibly, γ-amino-butyric acid. During the period after growth had ceased and before leaf senescence set in, however, all that could be detected were small amounts of aspartic acid, glutamic acid and their amides.

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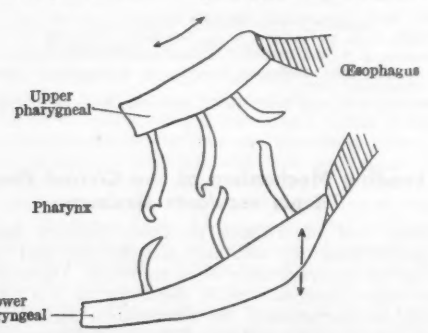
Feeding Mechanism of the Cichlid Fish, *Tilapia esculenta* Graham

The food of *Tilapia esculenta* consists mainly of phytoplankton[1], although zooplankton and insect larvæ[2] have occasionally been recorded. Diatoms are the most important food elements of the phytoplankton, particularly the filamentous *Melosira*. In the evidence for his 'Law of the Distribution of the Ngege', Graham[3] concluded that the simple gill-rakers of *T. esculenta* were not adapted for straining phytoplankton and that consequently the species obtained

its food from the living layer of diatoms in the bottom deposits. Recent work[3] on the feeding habits of this fish have shown that a considerable proportion of the diatoms taken must be considered as truly planktonic, and that the fish strains them from the water. The outer series of gill-rakers on the first branchial arch are relatively coarse (see plate in Graham[4]); but those of the inner series on this arch and both series on the three succeeding arches are finer, especially on the inner aspect of the fourth arch. The interdigitation of the gill-rakers forms a sieve between the arches which could retain coarse particles of food, for example, copepods, but not the individual organisms of the phytoplankton commonly recorded from the stomach. Some other method of food collecting must therefore be operative. A study of the histology and anatomy of the pharynx and buccal cavity has suggested a method whereby such fine food can be retained and swallowed.

The dorsal epithelium of the bucco-pharyngeal cavity is thrown into a number of low folds, thus increasing the surface area. Mucus cells occur in all areas of the oral and pharyngeal epithelium but are most concentrated and numerous along the posterior mid-dorsal surface of the mouth and pharynx and on the gill-arches.

Both the upper and lower pharyngeal bones are situated in the posterior part of the pharynx immediately anterior to the opening of the œsophagus, the passage between them sloping upwards at a sharp angle from the floor of the pharynx to the œsophagus. The lower bone is a broad triangular plate with the apex directed anteriorly; immediately above it, and opposing the greater part of its dentigerous surface, lie the paired upper pharyngeals, which are separated from one another by a narrow ridge of secretory epithelium. All three bones are beset with very numerous and fine teeth. The majority of the teeth on the lower pharyngeal are without distinct cusps and have the distal part strongly recurved (see diagram). Only in the most posterior rows are they distinctly cuspidate and erect. However, most of the upper pharyngeal teeth are markedly cuspidate, having a small posterior cusp and a larger, posteriorly curved cusp on the anterior side; together they form a hook-like tip directed towards the œsophagus (see diagram). Sets of small muscles move the upper pharyngeals antero-posteriorly and, to a lesser extent, laterally. Observations on the living fish show that this movement can be synchronous with, or independent of, the normal respiratory movements. The position of the lower pharyngeal can be altered so that its toothed surface can be brought into closer apposition with the upper pharyngeal teeth.



Diagrammatic representation of the pharyngeal bones and teeth of *Tilapia esculenta*. Teeth representative of anterior, middle and posterior tooth rows. Arrows indicate movement of bones when feeding

When feeding, it appears that the suspended phytoplankton is drawn into the buccal cavity, where it becomes entangled with the copious mucus secretion. Within the buccal cavity, turbulence, due to the intermittent nature of the inhalant current, would assist in this mixing. The mucus and food aggregates are carried posteriorly, but are prevented from escaping with the outgoing current by the gill-rakers. It is considered that the gill-raker sieve is sufficiently fine to prevent the free passage of these aggregates. Collection and concentration of the food apparently takes place in the posterior part of the pharynx, where the aggregates become entangled in the anterior teeth of the lower pharyngeal bone. When the upper pharyngeal bones are moved backwards, the hooked crowns of their teeth pass between the teeth of the lower bone and rake the mucus and entangled phytoplankton towards the œsophagus. Since the food is drawn through the lower teeth, large elements tend to be broken into smaller fragments. This explains the almost uniform lengths of the *Melosira* filaments which are found in the stomach of any one individual[1].

Even if the fish do feed on the bottom deposits—and there is evidence that they may occasionally do so—the mechanism described above will still be operative.

The opinion has been expressed[1] that the stomach of *Tilapia esculenta* may function merely for the storage of food prior to its digestion and assimilation in the duodenum. Histological examination of the stomach shows that the mucosa is well supplied with gastric glands similar to those found in other fish, and it seems likely that the initial stages of digestion occur in the stomach.

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Isolation of Intertidal Animals by Sea Barriers

In recent surveys of the Irish coast, we have established that several intertidal animals common in south-west Britain are not present in Ireland. The most notable absences are those of the barnacle, *Balanus perforatus* Bruguière, and the limpet, *Patella intermedia* Jeffreys (= *P. depressa* Pennant), both of which are found on the south coast of England west of the Isle of Wight, and off South Wales. *Balanus perforatus* extends only to the southern shores of Cardigan Bay[1], but *Patella intermedia* is found at least as far north as Holyhead; yet both are altogether absent from Ireland. Neither of these species has been suspected hitherto of being a recent immigrant to the British Isles; but of two other species which we failed to observe in Ireland, namely, the barnacle, *Elminius modestus* Darwin, and the bryozoan, *Bugula neritina* (L.), the former is known to be, and the latter thought to be, a ship-borne immigrant[2].

It seems most improbable that any of these species could be excluded from Ireland on account of climatic or hydrographic factors. While all are relatively warm-water forms, they extend to parts of the British coast (St. George's Channel, and, in the case of *Elminius*, the North Sea) which are subjected to colder winter sea and air temperatures than prevail over much of the south and west Irish coastline. The milder character of the Irish coast is indeed well illustrated by the distribution of certain intertidal animals which are not present on the colder parts of the British coast, and which, to some extent, may be regarded as indicators of climatic conditions. In order of apparent increasing tolerance of lower temperature or wider ranges of annual temperature these are: the sea urchin, *Paracentrotus lividus* (Lamarck), the top shells, *Osilinus lineatus* (da Costa), and *Gibbula umbilicalis* (da Costa), and the barnacle, *Chthamalus stellatus* (Poli). *Paracentrotus lividus*, although abundant throughout western Ireland, is virtually absent from south-west England, and of the other species, none is found in greater abundance in south-west England than in south and west Ireland.

It is tempting to suggest that *Balanus perforatus* and *Patella intermedia* may be representatives of a fauna which migrated northwards in post-glacial times, extending its distribution to Britain while the coastline was continuous with that of Europe, but failing to colonize Ireland before the land bridge was severed. There can be little doubt that existing deficiencies in the Irish land fauna and flora result from the existence of the sea barrier[3]. It is possible, however, that these species have been introduced to Britain within historical times, *Balanus perforatus* in particular being sometimes found on ships' bottoms. It is also possible that *Patella intermedia* is a recently evolved form[4]. Whatever explanation is adopted, it is difficult to escape the conclusion that even fairly narrow seas offer a barrier to predominantly intertidal animals.

The recent immigrant, *Elminius modestus*, affords a most valuable example of this effect in operation at the present time. Although now abundant on the eastern side of the Irish Sea, it has not yet appeared in Ireland, nor seriously invaded the Isle of Man, which at its nearest point, Ramsey, is only thirty-one miles from the nearest recorded locality for *Elminius* on the English coast. (To date, only two specimens have been found in the Isle of Man, both of them at Ramsey.) Yet in a coastwise direction the species has spread southward from Morecambe at a rate of approximately 20–25 miles a year, and now extends from Cumberland to Anglesey.

A greater spread along the coast is to be expected, because the tidal streams and the residual currents are obviously stronger parallel to the shore than at right-angles to it. Moreover, the establishment of a new community of sessile, or nearly sessile, creatures, which are either cross-fertilizing or have the sexes separate, requires the attainment of a minimum population density before the community can maintain itself. This is especially true of barnacles, which, though hermaphrodite, appear generally to be incapable of self-fertilization[5]. In contrast, certain molluscs, such as the oyster and the slipper-limpet, while normally protandrous hermaphrodites, seem to be occasionally capable of self-fertilization[6]. The threshold density of population for self-maintenance can be reached without difficulty on substrata adjacent to an established community; but at greater distances the larvæ become progressively more thinly dispersed. A critical distance must exist, related to the current system and the duration of the free-swimming stages, beyond which the rate of settlement of the larvæ is normally insufficient to reach the minimal population density within the life-time of an individual. The chance of colonization by a purely intertidal organism across a sea barrier wider than this becomes vanishingly small. From observations on the spread of *Elminius modestus*, which has a free-swimming life of about three to four weeks, and matures in the same season, it would appear that the critical distance along the North Wales coast would be at most 30–40 miles; this value is exceptionally interesting in comparison with calculations, based on salinity correlation coefficients[7], which indicate that the residual current in this area has a velocity of approximately 0·9 mile a day. However, this particular species can be transported in large numbers by shipping or on floating objects, so it is capable of reaching new areas far outside this critical range[8].

It is concluded that comparatively narrow sea barriers must be of importance in the distribution and evolution of predominantly intertidal animals and plants, the biogeography of which would appear to have much in common with that of terrestrial rather than that of entirely marine organisms.

We wish to thank the Royal Society for a grant in aid of the investigations, and Dr. J. A. Kitching, who has confirmed some of our absence records from his own exhaustive studies in the Lough Ine area.

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Ozonium Wilt of Guar and Cucurbit Plants in Bihar

Guar plants (*Cyamopsis psoraloides*) are widely cultivated in Bihar as fodder, and the green pods are also used as vegetables. A serious wilt of guar was noticed in restricted areas during September 1952 at several places, and as much as 20–25 per cent of the plants contracted the disease. The infected plants first showed yellowing of the leaves, loss of turgidity and finally wilted away. Examination of the collar portion of the plants showed thick strands of hyphæ enveloping and girdling the shoots and developing numerous chocolate-brown sclerotia 1–1·5 mm. in diameter. The hyphæ were compacted into definite strands of rhizomorphs unlike those of a similar fungus *Sclerotium rolfsii* Sacc. The fungus causing wilting of guar is identical with *Ozonium taxanum* Neal and West. var. *parasiticum* Thirumalachar[1].

Wilting of shoots of *Cucurbita maxima* incited by the same fungus was noticed in several places. On

the plants the vines were parasitized and killed by the fungus, which was apparently developing from the soil surface and possessing well-developed rhizomorphs. The portions of the shoots extending upwards from the place of infection wilted away and caused considerable losses to the growers. Portions of fruits in contact with the soil often rotted due to infection by the fungus. The strands of rhizomorphs crept up the fruit surface and after penetrating the tissue incited a wet rot. Since the sclerotia have been found to be viable for long periods in the soil, the possibility of the fungus building up in proportion and causing immense losses in these economic crops is great. Control measures are being investigated.

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A Method for computing the Optimum Size-Limit for a Fishery

In an exploited fishery, one of the main functions which a properly selected size-limit can have is to ensure that the weight of the yield is the maximum possible, with minimum losses due to unrealized growth or natural deaths. Where all fish reaching the limit are caught, determination of the correct value for the limit to achieve this purpose is theoretically simple, although in practice the basic data regarding growth- and mortality-rates, on which the determination is based, may not be easy to obtain. Such cropping conditions are found only in fish-farming. Normally, in fish stocks subjected to either angling or commercial fishing, only a small proportion of the fish reaching the limiting size pass into the catch. This causes a modification to the optimum value of the limit. Ricker[1] has pointed out that the size-limit must be less under these conditions than when cropping is complete, and has described a method for computing the optimum value when full data regarding growth, natural mortality and cropping-rates are available.

Results of practical value can be deduced from more easily obtainable data by making use of the property that, when the limit is at the optimum value, a very small change in the limit does not cause the size of the total catch to alter. A fish stock can be considered to consist of a number of groups of fish all of which are of the same size at any instant. Assume that cropping begins at the time T when the number of fish in the group which is just passing the limit is N, and that a fraction K of these fish are afterwards caught and have at time of capture a mean weight V, then the total weight of the crop obtained from these fish is KVN. If the cropping point is now made earlier by an interval dt, then the number of fish in the group at the cropping point will now be $N + dN$, where $dN = Nm.dt$ and m is the instantaneous natural mortality-rate. If the average weight of these fish is W and the instantaneous cropping-rate for fish of this size is c, then when the time T has been reached, $Nc.dt$ will have been caught weighing $WNc.dt$. The number of survivors to time T is therefore now $N - Nc.dt$. Since there is no reason for supposing that the conditions under which they are cropped have been changed, these survivors will give a yield of $KVN(1 - c.dt)$. The total crop from the original group when cropping begins at $T - dT$ is therefore $KVN(1 - c.dt) + WNc.dt$. When T is the point of commencement of cropping for maximum yield, this equals KVN and therefore:

$$KVNc.dt = WNc.dt,$$
$$\text{or } W = KV.$$

Thus, when the limit is that which gives the maximum yield, the weight of the typical individual fish at the limit is the product of the average weight of fish in the catch and the proportion of the fish passing the limiting size which are ultimately caught. Since this applies to each group in the population, it applies also to the population as a whole.

These two statistics are relatively easily measured in practice where adequate catch data are obtainable, the former by direct weighing of a sample of the catch, and the latter by obtaining recapture records for fish marked and liberated at the limiting size. The testing of the correctness of an existing limit can be done directly from these two measurements. If an existing limit is found to be incorrect, a first approximation to the correct value is immediately obtained. This approximation is subject to errors caused by the effect of the existing limit on both V and K. In many cases the original catch data will be in a form which will allow fairly accurate evaluation of V for a proposed new limit, and some indication of the effect on K may also be obtained. Application of these corrected values, if necessary in more than one step, should often enable a value of the optimum limit to be obtained which would be sufficiently accurate for experimental trial.

An estimated value cannot be obtained from data based on an existing limit if K is equal or close to unity, since in this case the average weight of the fish caught is automatically equal to the weight of a fish of the limiting size, and the approximation obtained is equal to the existing limit.

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A Suggested Alternative to the Correlation Coefficient for testing the Significance of Agreement between Pairs of Time Series, and its Application to Geological Data

It has for some time been realized that the ordinary test of significance of the correlation coefficient cannot be applied indiscriminately to pairs of time series, since serially adjacent observations are not in general independent. Tests of significance of the correlation coefficient have therefore been developed which are designed to make allowance for the effect of auto-correlation[1].

An alternative measure of agreement, which sacrifices some of the advantages of the correlation coefficient for the sake of simplification of the necessary test of significance, is proposed here. It is not a dimensionless quantity, and therefore it can only be used with pairs of time series which have approximately the same mean and variance. (This

requirement can be met by a linear transformation when necessary.)

Consider two time series, $p_1, p_2, p_3, \ldots p_r, \ldots$ and $q_1, q_2, q_3, \ldots q_r, \ldots$, corresponding terms in each series being denoted by the same suffix. We define the cross-difference product E by the relation :

$$E_{r,r+1} = \tfrac{1}{2}\{(p_r - p_{r+1})^2 + (q_r - q_{r+1})^2 - (p_r - q_r)^2 - (p_{r+1} - q_{r+1})^2\} \quad (1)$$

$$= (p_r - q_{r+1})(q_r - p_{r+1}). \quad (2)$$

If there are $2n$ terms in each time series, n independent values of E may be calculated, each being based on two adjacent terms in each series. The mean value of E, given by :

$$\frac{1}{n}\Sigma E = \frac{1}{n}(E_{1,2} + E_{3,4} + E_{5,6} + \ldots + E_{2n-1,2n}) \quad (3)$$

will be positive if, on the average, corresponding p and q terms differ less from each other than they do from their neighbours in the same series. In the contrary case, the mean will be negative. For a pair of independent random series, the individual values of E will tend to be distributed symmetrically about zero mean. We may take this as our null hypothesis. The significance of an observed positive mean value of E may then be tested by means of Student's t-test, or if n is sufficiently large, the labour of computing the values of the individual terms of equation (3) may be dispensed with ; and instead the frequencies of positive and negative signs of E may be found by merely inspecting the data, and the significance of an observed excess of positive signs tested by means of Pearson's χ^2.

A significant result will indicate that there is a relationship between the two series which cannot reasonably be attributed to a chance coincidence. It is easy to see that positive first-order autocorrelation is without effect upon the significance test, since the stronger it becomes the greater the resemblance between the two series necessary to give a positive mean value of E.

The cross-difference product E provides a simple means of testing the significance of the observed agreement between a pair of geological sections for which numerical data of any kind are available. Chronologies based on tree-rings and glacial varves are of particular interest, owing to the criticisms of principle which have been levelled against them. As an example of the method, I have taken measurements of two series of varves figured by Reeds[2] from Haverstraw, N.Y. (736 varves), and New Haven, Conn. (343 varves). These localities are about fifty miles apart. In order to eliminate long-term trends of purely local importance, I have taken the first differences of the actual varve thicknesses. There is a strong negative first-order autocorrelation in both series of first differences, which would seriously bias the mean value of E if equation (3) were used. I have therefore taken the values of E based upon alternate first differences, as follows :

$$\frac{1}{n}\Sigma E = \frac{1}{n}\{(p_1 - q_3)(q_1 - p_3) + (p_5 - q_7)(q_5 - p_7) + (p_9 - q_{11})(q_9 - p_{11}) + \ldots, \text{etc.}\} \quad (4)$$

The first differences of the two varve series of 343 pairs of varves give 85 independent values of E, of which 60 are positive, 15 are negative and 10 are zero. This gives $\chi^2 = (60 - 15)^2/(60 + 15) = 27{\cdot}0$. This value is not covered by the tables, but is far beyond the 0·001 level of significance. Alternatively, the standard error of the binomial gives a value of $P < 0{\cdot}000001$.

It will be realized that because Reeds chose the best out of about four hundred alternative ways of matching his varves, the above value of P must be multiplied by 400. The true value of P is thus approximately 0·0004, which is still strongly significant, so that we are bound to conclude that the observed agreement of the two varve series is very much greater than could be obtained by attempting to match up two unrelated time series.

In general, if P_n is the level of significance given by the test of the null hypothesis, and N is the number of alternative choices available in matching the varves, then the true level of significance of the result is given by $P_t = NP_n$. A varve correlation which is based on independent evidence, such as a band of volcanic ash, will have $N = 1$ and $P_t = P_n$.

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A New Method of testing the Pathogenicity of *Phytophthora fragariæ*

In a study of the influence of soil moisture and *p*H on red core disease of strawberries, caused by *Phytophthora fragariæ*, Hickman, Hickman and English[1] described an infection technique with plants in pots that gave consistent and rapid results, and the method was used for distinguishing physiological races[2].

Recently, we have developed a new method which not only shortens the experimental period from seven weeks to twelve days but also provides a yet more severe test of resistance. Essentially it involves mass inoculation of the roots by immersing them for about twenty-four hours in an active zoospore suspension of the fungus. The plants are then potted up in sand and left for a period of about twelve days. By this time, in susceptible varieties, infection is so extensive as frequently to cause pronounced wilting. The zoospore suspension is conveniently prepared by immersing large colonies of *P. fragariæ* in non-sterile pond water. The fungus is grown on plates of bean agar[1] until the mycelium has almost reached the edge of the plates. The colonies are then cut out, taking care not to sever the tips of the actively growing hyphæ, and supported on glass-rod frames in dishes of pond water so that they are just submerged. Two such colonies have been used to 500 ml. water. In 24–48 hr., at laboratory temperature (10–15° C.), a dense, opaque fringe of sporangia has grown out from the colony margin and, in addition, numerous sporangia have been produced from the under surface of the colony, particularly towards its edge. Sporangial formation and liberation of zoospores continues for two to three days.

This technique not only dispenses with the pre-inoculation period of one month, used in the original method, during which the potted runners were allowed to root, but economizes still further on space and labour. Thus, after immersion in zoospore suspension, the runners are planted five to a pot, instead of one. Lastly, the use of sand for potting simplifies the removal and washing of roots for examination.

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Dielectric Relaxation Processes in Ethanol

The existence of secondary regions of dielectric dispersion for a number of polar liquids has been inferred by several workers from radio-frequency and microwave dispersion data, as these extrapolate at high frequencies to values considerably larger than the square of the refractive index. Notable examples of this behaviour are water and the lower aliphatic alcohols[1], for which at temperatures from 0° to 60° C. the principal dipole dispersion region lies in the range of centimetre to metre wave-lengths. Saxton[2] has discussed the question in detail for water, methyl and ethyl alcohols, and found that his data, together with results in the wave-length region 50–150 μ, could be described by postulating a damped resonance dispersion in the millimetre wave-length region.

Results in this laboratory[3] for *n*-propanol, however, show that much of the discrepancy, at least at low temperatures, is explained by the existence of

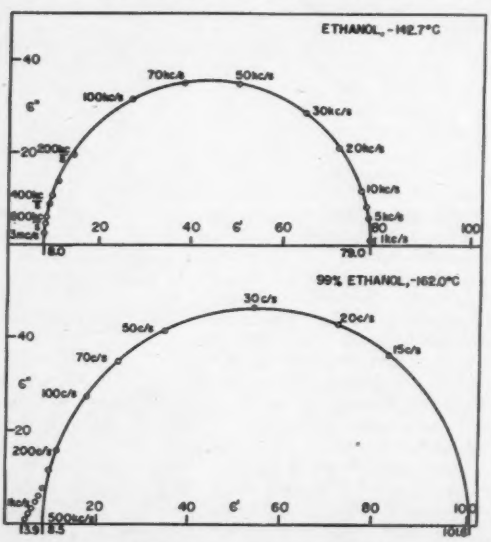

Fig. 1. Loci of the real (ε′) and imaginary (ε″) dielectric constants for ethanol at − 142·7° C., and 99 per cent ethanol at − 162° C. Frequencies of measurement are indicated

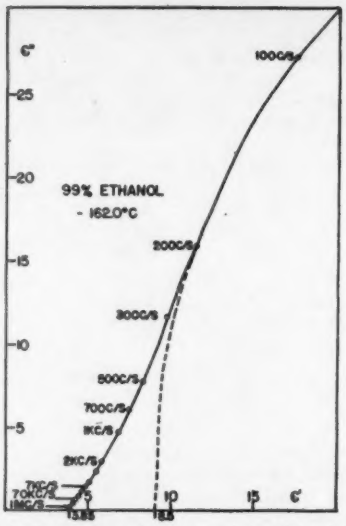

Fig. 2. High-frequency portion of the complex dielectric constant locus for 99 per cent ethanol at − 162° C. The dashed curve is the extrapolation of the low frequency locus (cf. Fig. 1)

secondary relaxation-type dispersions which fall in the range of radio- and even audio-frequencies at temperatures below − 100° C. A similar situation has been found in more recent studies of ethanol and ethanol–water solutions, which we report in this preliminary note because of the obvious implication that such dispersion processes are probable in alcohols generally, and quite possibly in other polar liquids as well.

Our measurements in the range 15 c./s.–5 Mc./s. show that the principal dielectric dispersion is quantitatively described by a simple dielectric relaxation process at temperatures below − 120° C., as the semi-circular complex loci of Fig. 1 illustrate. The high-frequency intercepts of 8·0 and 8·6 for the real part ε′ of the dielectric constant are seen, however, to be much larger than the square of the refractive index (n^2), in agreement with Saxton's conclusion[2] from measurements at room temperature.

Addition of 1 per cent by weight of water to ethanol makes possible considerable supercooling, and a second dispersion is observable at radio frequencies below − 147° C., as shown in Fig. 1 and in more detail in Fig. 2. This dispersion moves rapidly to lower frequencies on further cooling and its extent increases. Both effects are consistent with a relaxation rather than a damped-resonance type of polarization. Some evidence has been found for still a third distinct dispersion which would bring the dielectric constant even closer to the optical value of about two.

We surmise that the second dispersion is the counterpart of the behaviour found at millimetre wave-lengths for methanol and ethanol at room temperature, but that it is properly interpreted as a relaxation rather than damped resonance polarization. The possibility of more than one distinct relaxation process seems to have been largely overlooked in the past, possibly because of the tendency to think of molecular orientations in terms of simple dipoles.

A simple explanation of the observations can be given in terms of the OH and O*R* group moments

of an alcohol *R*OH : that the higher-frequency dispersion results from orientations of O*R* moments consistent with fixed intermolecular chain-bonding of OH groups, and the lower from orientations of the OH groups as their bonding changes. Both the relative extent and the similar temperature dependencies of the dispersions can be reasonably explained on this basis, as will be discussed in more detail elsewhere.

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New Method of Direct Quantitative Inorganic Paper Chromatography

Several methods for the direct determination of substances separated by paper chromatography have been described. They are based, apart from mere visual comparison, either on measuring the area of the coloured spot[1] or determining its transmission by different methods[2].

In this laboratory a method has been developed which, in our opinion, is much faster and at least as accurate as any of those mentioned and which, so far as we know, has not yet been described in the literature. It is based on the determination of the reflectance of the coloured spot at the wave-length of minimum reflectance, a Beckman *DU* spectrophotometer with standard reflectance attachment being used and a paper blank serving as the 100 per cent reflectance standard. The only reference to reflectance measurements we have found is in the paper by Winslow and Liebhafsky[3], which measured the reflectance and transmittance in the case of ordinary spot tests. These authors, however, appear to assume that reflectance measurements should obey Beer's law, whereas in fact the Kubelka–Munk law[4] must be applied. Also their technique is of little practical value, as they stated themselves.

For reflectance measurements to be reproducible two conditions must be fulfilled. (*a*) A surface of constant area should be used for the measurements. This can easily be achieved by making the spots slightly larger than the circular opening in the mask or tab which covers the samples in the sample-holder of the reflectance attachment (in the case of the Beckman *DU* spectrophotometer this opening has a diameter of 1 in.; it can, of course, be made smaller by the use of suitable masks). (*b*) The colour must be uniform over the surface of the spot. This can be achieved in the paper chromatography of inorganic cations only if the initial solution has a high acidity, and if the R_F value is kept very low ($< 0{\cdot}1$). We found that in this case it is possible to obtain spots of a very uniform colour, simply by letting the solution containing the cations spread through the paper. It is not even necessary always to use exactly the same volume of initial solution : in many cases the reflectance per unit area is independent, within certain limits, of the volume of the initial solution placed on the paper, and thus of the total area of the spot. This is a distinct advantage, as no accurately calibrated micropipettes are needed.

As an example, the procedure for determining nickel in the presence of other metals is here described. A series of standards containing 1–25 mgm. nickel in 100 ml. is prepared by dissolving a nickel salt in 3*N* hydrochloric acid. Similarly, a solution of the sample in 3*N* hydrochloric acid is prepared, the nickel content of which must fall in the same range. Small amounts of other acids do not appear to be harmful; but the final concentration should be very nearly 3*N*. If nitric acid, for example, is needed for dissolving the sample, it should be eliminated by evaporation on the water-bath before making up the hydrochloric acid solution. About 0·045 ml. (containing 0·5–11 μgm. nickel) of the unknown and of the standards is spotted on Whatman No. 1 paper and allowed to dry at room temperature. The spots thus produced are slightly elliptical, having diameters of 30–33 mm. The dimension of the spot is not critical; volumes between 0·03 and 0·06 ml. may be used with identical results.

For chromatography, the ascending technique of Williams and Kirby[5] is used. The sheets of paper measuring 23 cm. × 23 cm. are fastened together (with white cotton thread) in the shape of cylinders. Each can accommodate six spots : one blank (3*N* hydrochloric acid), three standards and two unknowns. They are placed in large jars containing acetone + 10 per cent 6*N* hydrochloric acid[6]. Development is preferably in the machine direction of the paper; after two hours it is complete. The sheets are dried for half an hour at room temperature, then half an hour at 60° C. Any residual acidity is neutralized by introducing them for a few seconds into a jar containing a dish filled with concentrated ammonia solution. They are then sprayed lightly (by means of an all-glass spray gun) with a 0·05 per cent solution of rubeanic acid in ethanol (94 per cent, carefully purified) containing 5 per cent (vol.) of concentrated ammonia solution. This solution is not stable and should be prepared immediately before use. Rubeanic acid gives coloured spots with iron, copper and cobalt, which have high R_F values. With nickel it produces a pure blue spot, which has moved only slightly ($R_F = 0{\cdot}03$) and is thus completely separated from interfering metals.

On each spot a circle of 26 mm. diameter is drawn in such a way that its centre coincides with the approximate centre of the spot. The spots are then cut out and their reflectance measured at a wave-length of 625 mμ with a slit-width of 0·7 mm. Accurate centring under the tab of the reflectance attachment is made easier by the circle drawn on the spot. The standard of 100 per cent reflectance is a blank spot, for which pure 3*N* hydrochloric acid is used. The concentration of the unknown can then be read by interpolation, using a graph previously prepared from measurements on standard spots corresponding to solutions the nickel content of which increases by 1 mgm./100 ml. increments. This graph should only be used for facilitating interpolation, as the reflectance values for a given concentration vary slightly from one chromatogram to another. We found that accurate interpolation is always possible using three standards : 3 mgm., 10 mgm. and 20 mgm. nickel per 100 ml. and two unknowns of different concentration.

The precision of the method is very high. The coefficient of variation of a single measurement

relative to the mean is 1·5 per cent for concentrations of 10–25 mgm. nickel per 100 ml. For concentrations down to 2 mgm. nickel per 100 ml. it is still about 3 per cent. The accuracy is equal to the precision if the amount of other cations is not more than ten times that of the nickel; for example, in a copper–nickel alloy (Belgian one franc coin) we found 24·55 per cent nickel, whereas chemical analysis gave 24·52 per cent nickel.

For alloys containing very low amounts of nickel, for example, ordinary steels, it is necessary to add to the developing solvent 4 per cent acetylacetone. In British Chemical Standard No. 239 (0·3 per cent carbon steel), which according to the certificate contains 0·23 per cent nickel, we found 0·21 per cent.

Full details of this investigation will be published elsewhere. Acknowledgment is made to Prof. E. Maes, head of the laboratory, for permission to publish this communication.

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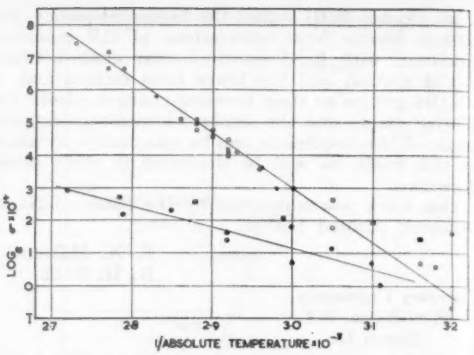
Effect of Temperature on the Conductivity induced in Insulators by X-Rays

During the course of an investigation into the conductivity induced in insulating materials by X-rays, it was observed that the conductivity of a length of polythene cable that had been irradiated six months before showed very marked dependence on temperature. In the case of similar cable unirradiated the effect was much less pronounced. Two samples of unirradiated cable were tested.

The previously irradiated cable had been subjected to a total of just under 5×10^5 r. given over the space of about a month at qualities of radiation ranging in value from 90 kV. H.V.L. = 1 mm. aluminium, equivalent wave-length 0·55 A., to 230 kV. H.V.L. = 2·3 mm. copper, equivalent wave-length 0·10 A.

The cable, mounted as a flat spiral inside a metal box, was heated by a stream of hot air flowing around it. A potential difference was applied between the sheath and central conductor of the cable, and the current flowing through the insulation was measured by means of a high resistance and D.C. amplifier. The voltage gradient was 775 volts per cm. The temperature was raised in steps to the highest value, and reduced in similar fashion. It was maintained within ± 2° C. of any required value until the conductivity reached equilibrium value. Because of the smallness of the currents being measured, the accuracy was rather low at the lower temperatures.

The results are presented in the accompanying graph, showing an approximately straight-line relation between the logarithm of the conductivity and the reciprocal of the absolute temperature. Thus the equation $\sigma = \sigma_0 \exp(-W/kT)$ which holds for semiconductors[1] appears to be applicable. From the slope of the graphs the value of W for the irradiated cable is found to be 1·45 eV., and for the unirradiated cable 0·50 eV.



Irradiated cable: ○, ascending temperature; □, descending temperature.
Unirradiated cable: ●, ascending temperature; ■, descending temperature

This suggests that conductivity in the latter may be due to electrons at a shallow level with respect to the conduction band, and in the former to positive holes produced by the radiation at a deeper level. If this is correct, then the contribution to the conductivity of the irradiated material made by the holes outweighs that due to impurity electrons as the temperature is raised.

It was pointed out by Farmer[2] that polystyrene shows a delay in returning to its original state after being irradiated. Polythene possesses a similar property, and it is a remarkable thing that six months after being disturbed, the mechanism of conductivity in the material had not returned to normal.

Note added in proof. The results obtained by Fowler and Farmer[3], for polythene cable both untreated and while undergoing irradiation, showed similar conductivity – temperature relationships to the above. They found much lower values of σ for unirradiated cable, and a value of $W = 1·5$ eV. This is difficult to understand, as the specimens used were obtained from the same supplier. It appears that there must be some variation in the treatment of the polythene during manufacture. The higher conductivity could be associated with increased impurity content. The value of W for the cable undergoing irradiation was found to be 0·42 eV., and this is consistent with the supposition that radiation raises electrons from non-conduction levels to a level that is shallow with respect to the conduction band. Further measurements on various specimens of polythene are required to resolve the differences between the results.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

LECTURER IN GEOGRAPHY (with good honours degree) at the Fourah Bay College, Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (August 5).

LECTURER IN MATHEMATICS (with good honours degree in mathematics, and preferably with some teaching experience, and competent to teach pure and applied mathematics up to final degree standard)—The Clerk and Treasurer, Dundee Technical College, 40 Bell Street, Dundee (August 8).

RESEARCH ASSISTANT IN ZOOLOGY (graduate specially qualified in entomology and helminthology)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (August 12).

LECTURER IN ELECTRICAL ENGINEERING (with honours degree in electrical engineering and industrial experience ; and preferably some teaching experience)—The Secretary of University Court, The University, Glasgow (August 22).

PHYSICISTS, SENIOR EXPERIMENTAL OFFICERS (*a*) (with good knowledge of radiation measurements, and preferably with experience of industrial radiography) to take charge of group dealing with control of radioactive decontamination and radiation surveys, biological assays, personal dosage monitoring, etc. ; (*b*) (preferably with experience with remote handling devices) for research and development on radioactive materials (Ref. A.189/53A). EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS (preferably with experience with high vacuum and metal evaporation techniques, construction and use of radiation measuring instruments, electron diffraction, high speed oscilloscopes for measurement of short time intervals) to assist in research and development work on radioactive materials (Ref. A.190/53A), at the Atomic Weapons Research Establishment, Aldermaston—The Ministry of Labour and National Service, Scientific and Technical Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No. (August 22).

ASSISTANT LECTURERS IN CHEMISTRY (with qualifications in physical chemistry)—The Registrar, The University, Manchester 13 (August 31).

LECTURER IN GEOGRAPHY (with special qualifications and experience in mineralogy and petrology, or in palæontology, or in stratigraphy)—The Registrar, University College, Keele, Staffordshire (August 31).

SCIENTIFIC ASSISTANT, Deputy Chief Scientific Officer grade (with a veterinary qualification, and a broad general knowledge of the sciences involved, with extensive research experience in one of them), for agricultural research which is directed to the solution of problems arising from all aspects of animal health and husbandry—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (August 31).

DEMONSTRATORS IN PHYSICS, CHEMISTRY AND GEOGRAPHY—The Registrar, University College, Keele, Staffs (September 1).

NATIONAL RESEARCH DEVELOPMENT CORPORATION SCHOLARSHIPS IN THE COMPUTING MACHINE LABORATORY—The Registrar, The University, Manchester 13 (September 1).

RESEARCH FELLOWSHIP IN SCIENCE at the University of Durham—The Secretary, 38 North Bailey, Durham (September 1).

RESEARCH STUDENTSHIPS IN GEOGRAPHY, PSYCHOLOGY, MATHEMATICS, PHYSICS, CHEMISTRY, BIOLOGY and GEOLOGY—The Registrar, University College, Keele, Staffs (September 1).

SENIOR EXPERIMENTAL OFFICER (with degree in a scientific or engineering subject, or a Higher National Certificate, or a graduate membership of a professional institution) AT THE FOREST PRODUCTS RESEARCH LABORATORY, Princes Risborough, Bucks, for research work and liaison with industry at high technical level on the uses of new timbers and their value as substitutes for traditional ones now unobtainable—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4234/53 (September 3).

ASSISTANT LECTURER IN MATHEMATICS (preferably with special interest in some branch of applied mathematics) in the Manchester Municipal College of Technology (Faculty of Technology in the University of Manchester)—The Registrar, College of Technology, Manchester 1 (September 7).

READER IN GEOGRAPHY in the Durham Division of the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (September 10).

PROFESSOR OF GEOLOGY at the Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 1).

LECTURER IN BACTERIOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 2).

ENGINEER, PHYSICIST or MATHEMATICIAN (with first- or second-class honours degree or equivalent qualification in engineering, physics or mathematics, and at least three years relevant postgraduate research experience) in the Ministry of Supply Research Branch, Tolworth, Surbiton, to work in small team engaged in design and development of wide range of survey, photographic and printing equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.194/53A.

PHYSICIST or RESEARCH ENGINEER (with first- or second-class honours degree, and research experience, preferably in textiles, plastics or similar materials) to carry out basic research on the mechanical properties of fabrics—The Director of Research, The British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

PROFESSOR OF CIVIL ENGINEERING at the Israel Institute of Technology, Haifa—The Secretary, The Technion Society of Great Britain, 13 Mansfield Street, London, W.1.

PROFESSOR, and an ASSISTANT PROFESSOR, IN THE DEPARTMENT OF PHYSICS—The Dean, A. A. Duri, College of Arts and Science, Baghdad, Iraq.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

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East Malling Research Station, near Maidstone, Kent. Annual Report 1952, 1st October 1951 to 30th September 1952 (Fortieth Year). Pp. 190+36 plates. (East Malling : East Malling Research Station, 1953.) 12*s.* 6*d.* ; 2 dollars. [295

Proceedings of the Society for the Study of Fertility. No. 4 : London Conference, 1952. Pp. 63+6 plates. (Cambridge : W. Heffer and Sons, Ltd., 1953.) 10*s.* [16

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1951–1952. (Cmd. 8847.) Pp. 44. (London : H.M. Stationery Office, 1953.) 2*s.* 6*d.* net. [16

The Registrar General's Statistical Review of England and Wales for the Two Years 1948–1949. Text, Medical. Pp. viii+370. (London : H.M. Stationery Office, 1953.) 10*s.* net. [36

Anti-Locust Bulletin 14 : Investigations of Suspected Outbreak Areas of the Desert Locust (*Schistocerca gregaria* Forskål) in Iran. By G. Popov. Pp. ii+32+8 plates. (London : Anti-Locust Research Centre, c/o British Museum (Natural History), 1953.) [36

Thirty-third Annual Report of the Board of the Institute of Physics, 1952. Pp. 16. (London : Institute of Physics, 1953.) [36

Department of Scientific and Industrial Research. Report of the Hydraulics Research Board with the Report of the Director of Hydraulics Research for the Year 1952. Pp. v+58+8 plates. (London : H.M. Stationery Office, 1953.) 6*s.* net. [46

International Council of Scientific Unions. Sixth General Assembly of the International Council of Scientific Unions, held at Amsterdam, October 1st to 3rd, 1952 : Reports of Proceedings. Edited by F. J. M. Stratton. Pp. viii+157. (Cambridge : At the University Press, 1953.) 7*s.* 6*d.* [46

Flora of Tropical East Africa. Edited by Dr. W. B. Turrill and E. Milne-Redhead. *Trapaceæ*. By J. P. M. Brenan. Pp. 4. 8*d.* *Onagraceæ*. By J. P. M. Brenan. Pp. 23. (London : Crown Agents for the Colonies, 1953.) [46

John Innes Horticultural Institution. Forty-third Annual Report, 1952. Pp. 32. (Hertford : John Innes Horticultural Institution, 1953.) 3*s.* [86

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Hannah Dairy Research Institute. Report for the Three Years ending 31st March 1953. Pp. 34+3 plates. (Kirkhill, Ayr : Hannah Dairy Research Institute, 1953.) [86

Air Ministry : Meteorological Office. Condensation Trails : Notes for use of Pilots. (M.O. 480 : A.P. 3315.) Pp. 4+2 plates. (London : H.M. Stationery Office, 1953.) 9*d.* net. [86

Council for the Preservation of Rural England. Twenty-seventh Annual Report, 1952–53. Pp. 60+4 plates. (London : Council for the Preservation of Rural England, 1953.) [86

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Colonial Office. Economics of Agriculture in a Savannah Village : Report on Three Years' Study in Genieri Village and its Lands, The Gambia. By Miss M. R. Haswell. (Colonial Research Studies No. 8.) Pp. 142. (London : H.M. Stationery Office, 1953.) 15*s.* net. [96

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(London: Commonwealth Institute of Entomology, 1953.) 15s.; 2.25 dollars. [186

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